

(Demo) Technical Report



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THE ECOLOGICAL HISTORY
OF THE
MALHEUR-HARNEY LAKES BASIN
OREGON

Phase I
Eocene Epoch To 1900

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INTRODUCTION

The Malheur-Harney Lakes Basin is located in the northern portion of the inter-mountain region. There is no outlet to the sea and the only way any water leaves is by evaporation, which is characteristic of other regions in the Great Basin. There are three principal water sources that drain into the Harney Basin. The Silvies River has its headwaters in the Blue Mountains and drains about 1350 square miles, entering Malheur Lake from the north. The Donner and Blitzen River heads on Steens Mountain, which is in the southeast corner of the Basin, and drains a 1000 square mile area. This system flows north from the mountain, eventually emptying into Malheur Lake from the south. Silver Creek flows from the Blue Mountains and empties directly into Harney Lake, draining a 900 square mile region.

The region today is characterized by sagebrush and junipers, and numerous rimrocks occur throughout the Basin. Presently the climate is semi-arid, but it has not always been that way: about 55 million years ago tropical forests covered the area. A drier trend began about 30 million years ago and continued until 3 million years, when the Pleistocene ice age began. In the late Pleistocene drier conditions returned until the climate became arid about 5000 years ago.

The purpose of this report is to describe the ecology of this region from the Eocene epoch to the present time. The ages of the various epochs discussed are presented below:

Tertiary	{	Eocene Epoch	54 - 38 Million years ago
		Oligocene Epoch	38 - 26 Million years ago
		Miocene Epoch	26 - 7 Million years ago
		Pliocene Epoch	7 - 3 Million years ago
Quaternary	{	Pleistocene Epoch	3 Million to 10,000 B.P.*
		Holocene (Recent)	10,000 B.P. to Present

* B.P. - Before Present (The number of years before 1952)

Much of the information on the early epochs is based on fossil deposits that have been located in east-central and southeast Oregon and in northwest Nevada. Although most of these deposits are not within the Basin's boundaries, climate and topography were apparently similar. Therefore, the flora and fauna were also undoubtedly similar.

This is an attempt to describe the ecology of the Malheur-Harney Lakes Basin from 54 million years ago to the present time. There are many gaps, especially on mammals in the Eocene, Oligocene, and Pleistocene, and birds from the Eocene through Pliocene. Until additional information becomes available these gaps will continue to exist.

EOCENE (54 - 38 million years ago)

Information on the fauna present in southeastern Oregon during the Eocene is limited; however, the flora is well known. Detling (1968) reported that lowlands extended from the Blue Mountains north to the Okanogan Highlands and west to the coast. Both the Blue Mountains and Klamath Mountains were intruded between the mid-Jurassic and mid-Cretaceous. At that time these mountains formed the western

margin of the North American Continent.

Sedimentation from the Blue Mountains had established the lowlands to the north and it is assumed similar sedimentary deposition occurred south of the mountain range. The Cascade Mountains and Coast Range were formed much later than the Eocene; in the absence of mountain barriers an oceanic influence prevailed throughout eastern Oregon. Climate and vegetation that occurred in the region at this time was much like that which occurs in Panama today.

Of the trees that dominated in the lowlands 54 million years ago, members of the laurel family were the most prevalent. Conifers were absent and there were no members of the families that are common in Oregon today. The environment was warm, with heavy rainfall and no freezing temperatures (Chaney 1956).

Flora

Vegetation was tropical. Plants that are closely related to the Eocene flora are presently located in southern Mexico, Central America and Asia. The following trees have been found in the Clarno Formation, northwest of John Day, and were probably typical of the vegetation that occurred in southeast Oregon.

Family: Lauraceae

Persea. The laurel family was the most dominant. The nearest relative that occurs in Oregon today is the Oregon myrtle (Umbellularia californica), which inhabits the southwestern portion of the state. Most other relatives are restricted to the warmer parts of the world, especially in Central America, and the nearest known relative is the avocado (Persia sp.).

Nectandra. The genus is now confined to tropical America, but was well represented in the Eocene forest of Oregon.

Cinnamomum. The genus is now found only in southeast Asia, and is the species from which cinnamon is secured.

Family: *Sabiaceae*

Meliosma. Members of the genus include aquacatillo, ciralillo and quayarota which now grow in Asia.

Ficus. Figs were well represented in the lowland forest. The two species that survive today are found in tropical Asia.

Platanophyllum. Ancestors of the sycamore were well represented in this area during the Eocene.

Tropical ferns were more numerous than in any other Eocene flora that has been examined from western North America, and palms were abundant. One large leaf of Cycad, of the genus Dioon, has been found in the Clarno Formation. Presently there are several living species in Mexico (Chaney 1956).

Fauna

Little information is available on the Eocene fauna, but future studies should help clarify what vertebrates were present in the tropical forest. Thus far, the Clarno has yielded crocodiles, fish, a small horse, rhinoceros, tapir, oreodont and titanotherium, but other faunal information is lacking.

OLIGOCENE (38 - 26 million years ago)

The tropical climate that persisted through the Eocene continued into the Oligocene. However, by the end of the epoch there was a return to a more temperate climate.

Flora

With cooling temperatures the tropical forest of the low plains was replaced by a temperate forest. Most of the temperate species probably migrated down the slopes of the highlands where temperatures had been cool enough for them to persist through the Eocene. Other genera and species may have come south from British Columbia and Alaska where the original temperate boreal forest flourished through the preceding epoch (Detling 1968).

There was general uniformity in the vegetation from the Pacific shores to east interior Oregon. However, world-wide plant migrations were underway in response to climatic changes (Chaney 1956). The North American continent was drifting northwest after land masses that were joined 200 million years before had split apart (Ostrom 1976).

Many of the plant genera that were represented in the Oligocene forest are familiar in the northwest today. Acer (maple), Alnus (Alder), Amelanchier (service-berry), Betula (birch), Corylus (filbert), Crataegus (hawthorn), Fraxinus (ash), Mahonia (hollygrape), Malus (apple), Philadelphus (mockorange), Populus (cottonwood) Quercus (oak), Ribes (currant), Rosa (rose), Salix (willow), Sambucus (elder), Viburnum (moosewood) and Vitis (grape) were all present. Others that inhabited the region but are now confined to eastern North America were Carpinus (hornbeam), Carya (hickory), Castanea (chestnut), Fagus (beech) Ilex (holly), Liquidambar (sweetgum), Nyssa (tupelo), Ostrya (hophornbeam), Tilia (basswood) and Ulmus (elm). The conifers were represented by Sequoia (redwood), Metasequoia (dawn redwood) and Taxodium (bald cypress). Thuja (cedar) and Libocedrus (incense-cedar)

were probably present, especially in the uplands. Abies (fir), Picea (spruce), Pinus (pine), Pseudotsuga (Douglas-fir) and Tsuga (hemlock) were present, but they were not abundant and the coniferous forests that occupy so much of the Pacific Northwest today had yet to develop (Detling 1968).

Redwoods were numerous, in places comprising three-quarters of the total forest. However, in one area oaks were numerous and redwoods made up only 3 percent.

Metasequoia, which is now confined to China, presently occurs in areas that have 43 inches of well-distributed rainfall and a mean temperature of 66° F (Chaney 1956). Probably those same climatic conditions that exist there today occurred here in the late Oligocene. By late Oligocene, however, topographic and climatic changes were occurring, providing habitat more suitable for grassland situations than for the dense forests that covered the region during the early portion of the epoch.

Fauna

Little information is presently available on the vertebrate fauna in eastern Oregon. Rhinoceros teeth and an oreodont skull have been found as well as one quail leg.

MIOCENE (26 - 7 million years ago)

Unlike the Eocene and Oligocene a great amount of information has been collected from the Miocene epoch. The tendency toward the cooler and drier climate that began in the Oligocene continued. The continent was still drifting toward the northwest, but a more local

factor that had a profound effect upon the climate was the volcanic activity which was building the Cascade Mountains. During the lower and middle-Miocene the mountains were low with only moderate influence on the climate to the east.

Flora

Metasequoia was the dominant tree in early Miocene, but as the Cascades continued to build Abies, Picea and Pinus were often abundant, while Pseudotsuga, Thuja and Libocedrus were also present. Several herbaceous families, including Malvaceae, Onagraceae, Polemoniaceae, Umbelliferae, Gramineae and Compositae made their appearances (Detling 1968). By mid-to late Miocene ecological conditions were variable with open woodlands existing adjacent to the plains. There were small lakes, streams, floodplains and even swampy areas, with wooded country at least in the valleys (Wallace 1946, Downs 1956).

In the late Miocene there were 68 species of plants represented in the Mascall formation near John Day. The most dominant was swamp cypress (Taxodium dubium), whose nearest relative T. distichum, is now found in the southeastern United States. Second in abundance was a black oak (Quercus pseudo-lyrata), a close relative of Q. borealis which is presently distributed in the eastern United States. Another close relative is Q. kelloggii, which ranges through California into central Oregon. A hickory (Carya bendirei) was the third most common. Hickories are now confined to the eastern part of the continent, ranging westward to Texas.

In decreasing order of abundance: a sycamore (Platanus dissecta), which resembles P. racemosa of the western United States; another

black oak (Q. merriami) with more slender leaves resembling those of Q. rubra of the eastern United States; a small-leaved maple (Acer bolanderi), resembling A. grandidentatum of the Rocky Mountains and A. leucoderme of the southeastern United States; a redwood (Sequoia heerii) which closely resembles Metasequoia glyptostroboides, the dawn redwood of central China; Ginkgo adiantoides whose only living relative has survived under cultivation in China; box elder (Acer negundoides) whose American equivalent ranges across the continent, with a similar living species, A. henryi, in Asia; and an elm (Ulmus speciosa) resembling U. fulva of eastern North America. These ten species made up 78 percent of the Mascall flora (Chaney 1956) and were probably identical to the flora that occurred throughout eastern Oregon.

More than half the flora resemble plants that are now found in eastern North America. Other than those previously mentioned, they include a swamp cottonwood (Populus heterophylla) which is now most common in river swamps in the lower Mississippi Basin; a birch similar to the paper birch (Betula papyrifera) of the northeastern United States and northward to Hudson Bay; a hophornbeam with a close living form (Ostrya virginiana) in the eastern portion of the United States; a beech whose nearest living relative (Fagus grandifolia) lives in the eastern United States; and a chestnut oak similar to Quercus prinus of the lower Mississippi Valley and the Atlantic Coast (Chaney 1956).

Thirty-four species have living equivalents in eastern Asia. Several fall into genera which are now restricted to Asia (e.g. Ginkgo,

Metasequoia, Cephalotaxus, Keteleeria, Pterocarya, Zelkova, Cercidephyllum, Machilus). However, many other species that are presently found in Asia are not greatly different from those that now live in the eastern United States.

There are 24 species which have near relatives living in western North America today. However, most of these have close relatives in eastern North America, or eastern Asia. There are only nine species, or 14 percent, that are strictly confined to western North America (Chaney 1956).

Fauna

Numerous forms of vertebrates have been described from the Miocene. Species from the early Miocene are represented in the John Day Formation and presented in Table 1. Those from several fossil localities, representing species that were present in mid-to late Miocene, are presented in Table 2.

Early Miocene:

Table 1

Mammals from the John Day Formation-early Miocene

(Merriam-Sinclair 1907)

Rodentia

Sciuridae

Sciurus wortmani

S. ballovianus

Aplodontoidae

Allomys (Meniscomys) hippodus

A. liolophus

A. cavatus

A. nitens

Mylagaulodon angulatus

Castoridae

Stenofiber gradatus

S. peninsulatus

Geomyidae

Pleurolicus sulcifrons

P. leptrophrys

P. diplophysus

Entoptychus planifrons

E. carifrons

E. minor

E. lambdoideus

E. crassiramus

E. rostratus

E. sperryi

Cricetidae

Peromyscus mematomon

P. parvus

Paciculus lockingtonianus

P. insolitus

Leporidae

one species

Perissodactyls

Equidae

Meshippus praestans

M. equiceps

M. brachylophus

M. longicristis

M. condoni

M. anceps

M. annectens

M. acutidens

Tapiridae

Protapirus robustus

Rhinocerotidae

Aceratherium pacificum

A. hesperium

A. truquianum

A. tubifer

A. annectens

Diceratherium armatum

D. nanum

Chalicotheridae

Moropus distans

M. senex

Artiodactyla

Entelodontidae

Daeodon shoshonensis

Elotheriidae

Elotherium humerosum

E. imperator

E. calkinsi

Tayassuidae

Thinohyus (Bothrolabis) pristinus

T. trichaenus

T. rostratus

T. subaequans

T. decedens

T. lentus

T. socialis

T. osmonti

Agriochoeridae

Agricochoerus trifrons

A. guyotianus

A. ryderanus

A. ferox

Merycoidodontidae (Oreodontidae)

Eporeodon occidentalis

E. o. leptacanthus

E. o. pacificus

E. trigonocephalus

E. major

E. socialis

Promerycochoerus superbus

P. chelydra

P. macrostegus

P. leidy

Hypertragulidae

Hypertragulus calcaratus

Allomeryx planiceps

Camelidae

Miolabis (Paratylopus) sternbergi

M. cameloides

Carnivores

Canidae

Paradaphaenus cuspigerus

Cynodictus (?) oregonensis

Nothocyon geismarianus

N. lemur

N. latidens

Mesocyon coryphaeus

M. brachyops

M. josephi

Temnocyon altigenis

T. wallovianus

T. ferox

Parictis primaevus*

Philotrox condoni

Enhydrocyon stenocephalus

Hyaenocyon basilatus

H. sectorius

Mustelidae

Oligoburnis crassivulters

Felidae

Archaelurus debilis

Nimravus gomphodus

N. confertus

Deinictis cyclops

Pogonodon platycopis

P. brachyops

P. davis

Hoplophoneus cerebralis

H. strigidens

Reptilia

Testudinidae

Stylemys oregonensis (turtle)

Squamata (lizard or snake)

Ogmophis oregonensis

- * Considered a Mustelid by Merriam and Sinclair, but recent information indicates the species was a Canid (Romer 1971).

Many families of mammals that are present today were well represented in the early Miocene. Archaic forms of mammals were already reduced, and it has been estimated that one-fourth of the families that had been in existence were extinct before the Miocene (Kurten 1971).

Rodents were represented by two arboreal species (Sciurus wortmani and S. ballobianus) which are members of the same genus as those living today. The family, Aplodontidae, was represented by five species. Four of these are members of the genus Allomys and the other Mylagaulodon. Although reduced to a single form today, Aplodontia rufa of the Pacific Northwest, the family did achieve a modest success in the Miocene (Romer 1971). Two species of Castoridae have been found; Steneofiber gradatus and S. peninsulatus. Although living beavers are aquatic, these species were burrowers. The pocket gophers (Geomyidae) were well represented by 10 species in two genera (Pleurolicus and Entoptychus), and the Cricetidae by two genera and four species. Of the Leporidae one species of rabbit has been found.

Perrisodactyls were present in abundance. Eight species of horses have been identified by Merriam and Sinclair (1907) as members of the genus Meshippus, but were probably Miohippus instead. One tapir (Protapirus robustus), and two genera of Rhinocerotidae (Aceratherium and Diceratherium), representing seven species, were also present in the early Miocene. One family that is now extinct, Chalicotheridae, was represented by two species of Moropus. These were big and horse like in appearance, but unique in that the front feet possessed claws. It has been suggested that the claws were used in dragging down branches, but a more probable explanation is that their food consisted of roots and tubers and that the front feet were used for digging (Romer 1971).

Along with perrisodactyls, artiodactyls were well established in southeast Oregon in the early Miocene. One off-shoot of the primitive swines was the Entelodontidae. These were large animals with huge

skulls, often reaching a yard in length. The incisors were long and pointed and the canines were heavy and showed wear grooves, which suggested a root-eating diet. Although it had many features resembling the true swine it was not closely related (Romer 1971). Four species of these large animals have been found in the lower Miocene deposits of eastern Oregon. Eight species of Thinohyus have been described from the John Day Formation. The genus is the oldest known North American peccary and was an off-shoot of the primitive pigs. The family Merycoidodontidae (Oreodontidae) was represented by two genera and 10 species. Oreodonts had evolved in the late Eocene and were the most successful American ungulates in the middle-teritary. Oreodont fossils outnumbered all other mammals combined in North America during the Oligocene and early Miocene, but disappeared in the Pliocene. A similar family appeared during the Oligocene and early Miocene -- the Agricochoeridae. Four species were known present in eastern Oregon. Most exceptional for an artiodactyl, the family had redeveloped claws on its feet. Little information is available on its habits, but it has been described as a tree dweller and a digger of roots and tubers. The family Hypertragulidae was represented by two species. These were small Artiodactyls that disappeared in the Miocene. Two species of camels of the genus Miolabis were residents of eastern Oregon. The family had evolved in North America in the Upper Eocene.

Carnivorous forms were abundant and Merriam and Sinclair (1907) have listed 25 species of canids and cats from the John Day Formation. The family Canidae, including nine genera and 16 species, was apparently abundant, which would be expected with the large number of herbivores

that occurred in the region at the time. Timmocyon was present which led to the modern dogs, wolves, jackals and foxes (Romer 1971). A mustelid, Oligoburnis, has also been recorded.

Five genera and nine species of cats have been found. True sabertooths and pseudo-sabertooths, such as Nimravus, were present. Hoplophoneus showed the essential characters of the later sabertooths, although it was not as highly developed (Romer 1971).

In addition to mammals, both turtle and squamata (snakes and lizards) remains have been found.

Mid-to Late Miocene Vertebrates.

The climate continued to cool and became drier as the Miocene progressed. However, water was still abundant as fish and turtle remains have been found at scattered localities.

Fourteen species of rodents have been located at six fossil sites in eastern Oregon and northwest Nevada. At least four Scurrids were present, and the ground squirrels (Citellus longirostris) had made their appearance. Three species of Heteromyidae were inhabitants of the region (Diprionomys (?) oregonesis, Prodipodomys (?) mascallensis, Peridomys (?) oregonesis). Aplodontoidae was still present with two species, Lidontia alexandrae and Aplodontia alexandrae. One of the most specialized of rodent forms arose during the Miocene (Mylagaulus). It was about the size of a marmot with powerful front legs suggesting digging habits. It was unique among rodents in having a well-developed median horn above the forehead. Mylagaulus monodon, M. laevis and M.

pristinus have been found and were apparently common in this region. One Castoridae (Chalicomyid) completes the list of rodents.

Rabbits and hares were more evident in mid-to late Miocene times, based on the species that have been found. Palaeologus was the familiar leporid.

Elephants had reached the region in the Miocene. Mastodon remains have been located at two fossil localities (a third was added in the spring of 1978 near Ironside, Oregon).

Of the perrisodactyls, the Equidae were represented by four genera and 13 species. Sizes varied from the larger Hypohippus to the smaller Archaeohippus. Parahippus was the beginning of the third structural stage in horse evolution. The side toes of the feet were so reduced that they probably did not touch the ground. It appears that Parahippus was a transition form from the old forest dwellers of previous epochs to modern plains-dwelling grazing horses (Romer 1971). This also corresponds to vegetation and climatic changes, grasslands became more established as the region became drier. Directly descending from Parahippus was Merychippus which was characteristic in the late Miocene. Merychippus is undoubtedly an ancestor of the later horse types. At least three species of Rhinocerosis and one tapir occurred in the area. A species of Moropus was still present in the middle Miocene, but disappeared before the end of the epoch.

Artiodactyls were abundant and at least 21 species have been found. Oreodonts were the most successful in the mid-Tertiary. Four species have been located from eastern Oregon, including Merychys. Most oreodonts were conservative in structure, but Merychys showed

specialization by increased size. Three species of peccaries (Tayassuidae) were also present. One genus, Platygonus, was still in existence in the Pleistocene. Thinohyus is the oldest known North American peccary. First reported from the Oligocene, the genus was still present in mid-to late Miocene in this region. Camels were well represented, with Dromemeryx the most widely distributed. Miolabis was present in the Mascall Formation and one species from Virgin Valley, Nevada was close to Procamelius. Palaeomercycidae, the ancestors of deer and giraffes, was represented by Blastomeryx. Blastomeryx is unique in that no horn was present, but instead it had stout upper canine tusks. The Antilocaparidae made their appearance in the Miocene. Three species of Merycodus have been found in eastern Oregon. They were abundantly present in the American plains region and fossil evidence indicates they were also plentiful in this area. The presence of this genus from mid-Miocene into later epochs shows that grassland habitats were becoming more evident.

Along with the herbivores, carnivores were also abundant. Fourteen species of carnivores have been recorded. Of the Mustelids, the modern genus Martes was present, but only one cat has thus far been found. Canids were well represented with at least nine species, and the Procyonidae had made their appearance with the genus Pliocyon.

As the epoch was coming to an end geologic changes were taking place. Extensive lava flows were covering the lowlands, leaving mountainous areas exposed. Locally, Steens basalt extended westward to Paisley and eastward past the Trout Creek and Sheephead Mountains. This basalt flow had its maximum depth of 4000 to 4500 feet on Steens

Mountain, but along the periphery, flows were shallow (Baldwin 1959).
Lava flows of this magnitude surely had a catastrophic influence on
the flora and fauna of this region.

TABLE 2
Mammals from the mid-to late Miocene
of eastern Oregon and northwestern Nevada

SPECIES	VIRGIN 1. VALLEY, NEV.	SUCKER CR 2. & SKULL SPRS OREGON	3. MASCALL, OREGON	4. CROOKED RIVER OR.	5. BEATTY'S BUTTE, OR
Rodentia					
<u>Sciurid</u> (?) sp		X			
<u>Sciurus malheurensis</u>		X			X
<u>Sciurus tephros</u>		X			
<u>Citellus longirostris</u>		X			
<u>Arctomyoides oregonensis</u>			X		
<u>Diprionomys</u> (?) <u>oregonensis</u>		X			
<u>Prodipodomys mascallensis</u>			X		
<u>Peridomys</u> cf. <u>oregonensis</u>			X		
<u>Mylagaulus monodon</u>	X		X		
<u>M. laevis</u>		X	X		X
<u>M. pristinus</u>	X				
<u>Lidontia alexandrae</u>		X			X
<u>Aplodontia alexandrae</u>	X				
<u>Chalicomyid</u> sp.		X			

TABLE 2 (Continued)

SPECIES	VIRGIN VALLEY, NEV. 1.	SUCKER CR & SKULL SPRS. OREGON 2.	3. MASCALL, OREGON	4. CROOKED RIVER OR.	5. BEATTY'S BUTTE, OR
Lagomorpha					
<u>Hypolagus</u> cf. <u>vetus</u>			X	X	
<u>Oreolagus nevadensis</u>	X				X
<u>Palaeolagus nevadensis</u>	X				
<u>Lepus</u> <u>vetus</u>	X				
Perrisodactyl					
Equidae					
<u>Hypohippus osborni</u>	X	X		X	X
<u>Parahippus brevidens</u>				X	
<u>P. avus</u>	X	X	X		X
<u>P. sp.</u>				X	
<u>P. near coloradensis</u>		X			
<u>Archaeohippus ultimus</u>			X	X	X
<u>Merychippus relictus</u>			X	X	
<u>M. isonesus</u>	X	X			X
<u>M. brevidontus</u>		X			
<u>M. serversus</u>			X	X	X
<u>M. primus</u>					X
<u>M. campestris</u>					X
<u>M. sp.</u>			X	X	X
Tapiridae					
<u>Tapirid</u> sp.		X			

TABLE 2 (Continued)

SPECIES	VIRGIN 1. VALLEY, NEV.	SUCKER CR 2. & SKULL SPRS. OREGON	3. MASCALL, OREGON	4. CROOKED RIVER OR.	5. BEATTY'S BUTTE, OR
Rhinocerotidae					
<u>Aphelops megalodus</u>					X
<u>Aphelops</u> sp.	X			X	X
<u>Rhinocerotid</u> sp.		X			
Mastodon					
Mastodon (Tetrabelodon)(?) sp.	X	X			
Chalicotheridae					
<u>Moropus</u> (?) sp.	X	X			
Artiodactyl					
Merycoidodontidae					
<u>Oreodontia</u> sp.			X		
<u>Merychus</u> (?) sp.	X				
<u>Ticholeptus</u> (?) sp.		X	X	X	
Tayassuidae					
<u>Prosthenops</u> (?) sp.		X			
<u>Thinohyus</u> (?) sp.	X	X			
<u>Platygonus</u> (?) sp.		X			
Camelidae					
near <u>Procamelius</u>	X				
<u>Dromemeryx</u> near <u>borealis</u>	X	X	X	X	X
<u>D.</u> sp.	X		X	X	
<u>D.</u> sp.			X	X	
<u>Camelid</u> (?) sp.		X	X		X

TABLE 2 (Continued)

SPECIES	VIRGIN 1. VALLEY, NEV.	SUCKER CR 2. & SKULL SPRS OREGON	3. MASCALL, OREGON	4. CROOKED RIVER OR.	5. BEATTY'S BUTTE, OR
<u>Camelid</u> (?) sp.		X			
<u>Miolabis transmontanus</u>			X		
Palaeomercycidae					
<u>Blastomerycini</u> sp. undeter.			X		
<u>Blastomeryx mollis</u>	X				
<u>B.</u> (?) sp.		X			
Antilocapridae					
<u>Merycodus</u> near <u>furcatus</u>	X				
<u>M. nevadensis</u>		X			
<u>M.</u> sp.		X			X
Carnivora					
Canidae					
<u>Tephrocyon kelloggi</u>	X				
<u>T.</u> (?) <u>rurestris</u>	X				
<u>T.</u> (?) sp.	X				
<u>Canid</u> sp.		X		X	X
<u>Amplicyon</u> cf. <u>sinapis</u>		X	X		
<u>A. frenders</u>		X			X
<u>Euoplocyon</u> (?) sp.		X			
<u>Hemicyon</u> sp.		X			
<u>Tomarctus rurestris</u>		X	X	X	
Procyonidae					
<u>Probassaricus antiquus</u>	X				
<u>Pliocyon medius</u>		X			

TABLE 2 (Continued)

SPECIES	VIRGIN 1. VALLEY, NEV.	SUCKER CR 2. & SKULL SPRS. OREGON	3. MASCALL, OREGON	4. CROOKED RIVER OR.	5. BEATTY'S BUTTE, OR
Mustelidae					
<u>Leptarctus oregonesis</u>		X	X		
<u>Martes gazini</u>		X			
Felidae					
<u>Felis</u> sp.	X				
1. Merriam 1911					
2. Scharf 1935; Gazin 1932					
3. Downs 1956					
4. Downs 1956					
5. Wallace 1946					

PLIOCENE (7 - 3 million years ago)

In the lower Pliocene, Axelrod (1944) provided a list of plants that were present east of Steens Mountain (Table 3). These plants grew in an area of moderate relief with rolling hills, and were deposited in a lake basin. There were no oaks in the region and the vegetation must have resembled the Klamath Mountain region of northern California today. Precipitation was 20 to 23 inches. Temperatures averaged from 57° to 58° F with extremes of 20° to 85° F.

By the mid-Pliocene the Coast Range and the Cascade Mountains had been elevated to their present elevations; the modern ranges and

intervening basins were well established. The culmination of this xeric trend was reached by mid-Pliocene. The continued presence of east American tree species indicate that there was still considerable rainfall. It has been postulated that 15 to 17 inches of precipitation was the average during this time. Mid-Pliocene floras indicate that the climate was semi-arid, milder and wetter than at present (Detling 1968).

Woodlands and forest only occurred along streams and at higher elevations, with savanna and open grasslands occupying much of the area that was forested in earlier epochs (Shotwell 1963). Chaney (1956) lists elm, sycamore and willow along the streams around John Day and Detling (1968) reported that elms, poplars, Prunus and willows grew along the streams throughout the northern Great Basin.

By late Pliocene a widespread climatic change took place which initiated a return to moister and cooler conditions, leading to the ice age of the Pleistocene. Although the Coast Range and Cascades still acted as barriers to moisture from the Pacific Ocean, the lower temperatures and consequent lower evaporation rates may have resulted in a greater effective precipitation than that of the mid-Pliocene. However, the amount of summer rainfall proportionate to the annual total had dropped sharply. This eliminated the east American and east Asian flora that depended upon wet summers for their continued existence (Detling 1968).

TABLE 3

Flora that was present near Steens Mountain
in the early Pliocene (Axelrod 1944)

Species

Conifers

Abies alvordensis

A. klamathensis

Picea lohontense

P. sonomensis

Pinus alvordensis

Pinus sp.

Pseudotsuga sonomensis

Juniperus alvordensis

Angiospermae

Naiadales

Potamogetonaceae

Potamogeton sp.

Populars

Populus payettensis

P. pliotremuloides

P. payettensis

Betulaceae

Carpinus grandis

Ranales

Berberidaceae

Mahonia reticulata

TABLE 3 (Continued)

Species
Rose
* <u>Amelanchier</u> <u>alvordensis</u>
* <u>Cercocarpus</u> <u>antiquus</u>
<u>Cercocarpus</u> <u>holmesii</u>
<u>Photinia</u> <u>sonomensis</u>
<u>Prunus</u> <u>harneyensis</u>
<u>Rosa</u> <u>alvordensis</u>
<u>Sorbus</u> <u>harneyensis</u>
Others
<u>Amorpha</u> <u>condoni</u>
* <u>Rhus</u> <u>alvordensis</u>
* <u>Acer</u> <u>alvordensis</u>
<u>Ceanothus</u> <u>precuneatus</u>
<u>Arbutus</u> <u>idahoensis</u>

* Comprised 90% of the flora.

Fauna

Several Pliocene fossil sites have been located and a list of species is presented in Table 4.

Shotwell (1963) reported on sites at Juntura and Drewsey. At Juntura the deposition area was apparently a perennial shallow fresh-water lake. Three palecypods (mussels) and five gastropods have been located, with the snail Carinifex shotwelli the most abundant.

Clemmys hesperia, a tortoise, has been described from the Rattlesnake Formation near John Day.

The Insectivora were represented by two species. A mole, Scapanus, and a shrew, Hesperosorex, have been found at Juntura. Shrews still occur in southeast Oregon, but moles have since disappeared; however, two species of Scapanus do occur within 200 miles of this site today.

Rodents are well represented and three genera that were inhabiting the area in the Pliocene are still present today. These are the marmots (Marmota), ground squirrels (Citellus) and white-footed mice (Peromyscus). The remaining genera have since become extinct. Several aplodonts were present (Tardontia, Liodontia, Aplodontia). These genera of mountain beavers no longer exist. It is presently believed that the Aplodontids were the ancestors of the specialized Mylagaulus that was so widespread in eastern Oregon through the Pliocene. The pocket gophers were represented by Entoptychus and Pliosacomys and pocket mice (Heteromyidae) by the genus Diprionomys. The family Cricetidae was present with Peromyscus and Microtoscopes. Three members of the Castoridae (beaver family) have been found (Hystricops, Eucastor, Dipoides).

Hypolagus and Lepus were the genera of rabbits that were present. Hypolagus disappeared in the Pleistocene and the genus Lepus is the common form found in southeastern Oregon today (Black-tailed Jackrabbit, Lepus californicus).

TABLE 4
The fauna of southeastern Oregon
during the Pliocene

SPECIES	1. Juntura	2. Drewsey	3. 1000 Creek	4. Rattlesnake Formation
MOLLUSKS				
Pelecypoda				
<u>Sphaerium lavernense</u>	X			
<u>Pisidium clessini</u>	X			
<u>P. indeter.</u>	X			
Gastropoda				
<u>Fluminicola junturae</u>	X			
Hydrobiidae	X			
<u>Viviparus turneri</u>	X			
<u>Radix junturae</u>	X			
<u>Carinifex shotwell</u>	X			
REPTILIA				
<u>Clemmys hesperia</u>				X
MAMMALS				
Insectivora				
<u>Hesperosorex</u> sp.	X			
<u>Scapanus</u> sp.	X			
Rodentia and lagomorphs				
<u>Tardontia</u> sp.	X			
<u>Liodontia furlongi</u>		X		

TABLE 4 (Continued)

SPECIES	1. Juntura	2. Drewsey	3. 1000 Creek	4. Rattlesnake Formation
<u>Myiagaulus</u> sp.	X	X	X	
<u>Entoptychus minimus</u>			X	
<u>Epigaulus minor</u>	X			
<u>Diprionomys</u> sp.			X	
<u>Citellus</u> sp.	X	X	X	
<u>Aplodontia alexandrae</u>			X	
<u>Cupidinomys</u>	X			
<u>Arctomys</u> sp.			X	
<u>Hystriopsis brownii</u>	X	X		
<u>Pliosacomys dubius</u>		X		
<u>Eucastor</u> sp.	X		X	
<u>Dipoides stirtoni</u>		X	X	
<u>Peromyscus</u> sp.	X		X	
<u>Microtus</u> <u>disjunctus</u>		X		
<u>Hypolagus</u> sp.	X			X
<u>H. oregonensis</u>		X		
<u>Lepus vetus</u>			X	
Proboscidea				
<u>Platybelodon furlongi</u>	X			
<u>Amelebelodon</u> (?)		X		
<u>Mammut</u> (?) <u>Miomastodon</u> sp.	X			
<u>Mastodon</u> (<u>Tetrobelodon</u> ? sp.)			X	

TABLE 4 (Continued)

SPECIES	1. Juntura	2. Drewsey	3. 1000 Creek	4. Rattlesnake Formation
Perrisodactyl				
Equidae				
<u>Hipparion</u> sp.	X	X	X	
<u>Pliohippus</u> sp.		X	X	X
<u>Neohipparion</u> <u>occidentale</u>				X
<u>N. sinclairi</u>				X
Tapiridae				
Genus underter.	X			
Rhinocerotidae				
<u>Aphelops</u> sp.	X			
<u>Teleoceras</u> sp.		X	X	
<u>Rhino</u> undeter				X
Artiodactyla				
Tayassuidae				
<u>Platygonus</u> <u>rex</u>				X
<u>Prosthenops</u> sp.	X	X	X	X
Merycoidontontidae				
<u>Ustatochocrus</u> sp.	X			
Camelidae				
<u>Procamelus</u> sp.	X	X		
<u>Megatylopus</u> sp.	X	X		
<u>Pliauchenia</u> sp.			X	

TABLE 4 (Continued)

SPECIES	1. Juntura	2. Drewsey	3. 1000 Creek	4. Rattlesnake Formation
Antilocapridae				
<u>Spenophalos</u> sp.		X	X	
<u>Ilingoceros alexandrae</u>			X	
<u>Ilingoceros schizoceras</u>			X	
Megalonychidae				X
Carnivora				
Canidae				
<u>Osteoborus</u> sp.	X	X		
<u>Aelurodon</u> sp.	X		X	
<u>Vulpes</u> sp.	X			X
Mustelidae				
<u>Martes</u> sp.	X			
<u>Pliotaxidae</u> sp.	X	X		
<u>Sthenictis</u> <u>junturensis</u>	X			
<u>Eomelivora</u> sp.	X			
<u>Lutravus halli</u>		X		
Felidae				
<u>Pseudaeluras</u> sp.	X		X	

1. Shotwell 1963

2. Shotwell 1963

3. Merriam 1911

4. Downs 1956, Merriam
and Sinclair 1907

Elephants, which had arrived in North America in the Miocene were well represented in the Pliocene. Both Platybelodon and Amebelodon (family Proboscidea) occurred in southeast Oregon. These shovel-tusk elephants probably evolved in Asia, but developed in the Western Hemisphere. They had the common character of the lower jaw and tusks formed in a spade or scoop-like structure, which was apparently used for digging (Kurten 1971). Another representative of the Proboscidae that was residing in Oregon in the Pliocene was of the genus Mastodon. Members of this family have been found at Juntura and Drewsey, Oregon and Thousand Creek, Nevada.

Horse evolution had become well advanced by the Pliocene. Hipparion was about the size of a pony and apparently evolved in the New World, although there is some controversy as to its origin. It never became prominent in the New World, but was tremendously successful in the Old World after crossing the Bering Land Bridge (Beringia) in early Pliocene (Kurten 1973). Neohipparion was confined to North America and both of these species retained three-toed feet. Another group of large hypsodont horses was present in the Pliocene of North America and was also apparently abundant in southeast Oregon -- the Pliohippus. This was the only line in which the side toes became further reduced and were finally lost. This group was the forerunner of the modern horse Equus which appeared in the Pleistocene (Romer 1971). A genus of Tapiridae was present in the region in the Pliocene, but the family was soon to be pushed into South America by Pleistocene climatic changes. The Rhinocerotidae were represented by Aphelops and Teleoceras. The group was dying out in North America, and only

the Teleoceras survived to the end of the Pliocene. These were short-legged, round bodied and broad-footed rhinos with a build somewhat like a hippopotamus and probably with similar amphibious habits.

Several artiodactyls have been found from Pliocene fossil deposits of eastern Oregon. The peccaries were represented by two forms. Platygonus survived into the Pleistocene and Prosthenops has been found from several fossil localities. Oreodonts were still present, but only one genus (Ustatochoerus) has thus far been found from this epoch in southeast Oregon. In the Pliocene, oreodonts had become very rare in North America and only one genus survived into late Pliocene. The camels prospered and three genera (Procamelus, Metatylopus, Pliauchemia) have been reported from the region. Along the camel evolutionary line there was an increase in size in such forms as Procamelus and Pliauchia (Romer 1971). But Megatylopus had already reached its maximum size and stood 15 feet tall (Ostrom 1976).

The Antilocapridae was represented by two genera; Sphenophalos and Ilingoceros. A reduction in the family to a single living species (pronghorn antelope) may be related to the invasion from Asia by the bison during the Pleistocene. Merycodus, which was present during the Miocene in southeast Oregon, has not been located in Pliocene fossil deposits, but it was surely present. This early ancestor of the pronghorn was probably confined to open grasslands where conditions were not ideal for fossil deposition.

The ground sloths (Megalonychidae) moved into North America from South America during the Pliocene. The long separation of North and South America came to an end in this epoch allowing for passage of

North American forms such as tapirs and peccaries to move south and other forms such as sloths to move north.

Many carnivores were present in the Pliocene, feeding on the large number of herbivores that were present. One genus, Osteoborus, was a member of a group of canids that failed to reach recent times. They were hyena-like, with peculiarly swollen foreheads; they were commonly known as short-faced dogs. Aelurodon was still present in the lower Pliocene but disappeared shortly afterward. Vulpes, the same genus as modern day foxes, was also present during this epoch after first appearing in the late Miocene of North America. Mustelids were well represented. Martes (same genus as the present day pine marten) was present near Juntura. Pliotaxidae (an early badger) and Lutravus (an otter) occurred in this region as did two other mustelids. The cats were represented by one genus (Pseudoeluras). This genus was in the lynx-panther size range. It was a biting cat; depending on a sudden bounce and quick bite into a vital organ to obtain prey.

Several bird species have been found in southeastern Oregon that date from the Pliocene. A cormorant, Phalacrocorax leptopus; a Ciconidae, resembling a stork; a straight-billed flamingo (Palaelodus ambiguus); and another member of the heron and egret family, Megapalaelodus opsignus were present at Juntura. Other species found at the same locality were a goose (Eremochen russelli), a goldeneye type duck (Ocyplonessa shotwelli), another Anseriformes (Querquedula pullulans), an accipiter hawk (Neophrontops dakotensis) and a coot (Fulica infelix) (Brodkorb 1961). Two of these genera (Fulica and Phalacrocorax) are still found in the region today.

At the close of the epoch the Tertiary Period came to an end. The ice-age was beginning. The Pliocene was the climax of the age of mammals before the coming of the cold. A survey of mammal families by the end of the Pliocene showed that some extinction had already begun.

PLEISTOCENE (3 million to 10,000 B.P.)

During the Pleistocene epoch four advances of the ice sheet moved south into the northern United States, and extended further southward into the mountain ranges. These glacial periods were presumably separated by warm periods. As the glaciers retreated from Steens and other mountain ranges, excessive run-off produced large bodies of water within the Great Basin. Lake Malheur was the third largest of the basin lakes and covered 920 square miles with depths to 70 feet.

Several other lakes were present in this region during the Pleistocene. One had a depth of 100 feet and covered Christmas and Silver Lake Valleys, near Fort Rock. Lake Chewaucan was 300 feet deep and covered Abert and Summer Lakes, and Chewaucan Marshes. Alkali, Warner, Catlow and Alvord Valleys were all inundated by pluvial lakes that ranged in size from 200 to almost 500 square miles each.

Many of these large lakes had caves nearby that provided shelter for the Paleo-Indians that have occupied the region from at least 13,200 B.P. (Houghton 1976).

It is assumed that the pattern of vegetation adjusted to the conditions of either advancing or retreating glaciers. Most of the

species of plants had evolved into the same forms that occur in the region today.

During periods of glaciation the boreal forest may have occupied the plateau south of the ice sheet into the northern Great Basin of southeast Oregon. Boreal forests were present on the peaks of Steens, Hart and Pueblo Mountains and on Abert Rim. By the end of the Pleistocene the boreal forest occupied at least the uplands, with ponderosa pine (Pinus ponderosa) occupying the lower slopes, and grasses and chenopods on the plateaus. As the glaciers retreated true grasses, composites and chenopods moved in and replaced the boreal forest (Detling 1968).

During the ice age the seas were receding and the continents became joined by land bridges, with land animals migrating from continent to continent. The sizes of animals increased, especially the mammals. Little information is available on species that were present in southeast Oregon in the early Pleistocene, but by the close of the epoch forms that inhabit the region today were present. Generally, in the early portion the Rodentia were represented by an extremely large species of beaver (Castoroides) that was near the size of a black bear (Ursus americana). An explosive evolution of voles and rats occurred. The vole explosion occurred in the early Pleistocene and the rat explosion toward the end of the period.

Three-toed horses were still found, but they soon died out and were replaced by single-toed horses like Equus, which is the genus that lives today. By the end of the Pleistocene all species of horses had died out in North America and would not be seen again until

reintroduced by white man. Tapirs continued to survive, but gradually died out in North America. The chalicotheres were also becoming extinct. Rhinos did not live into the Pleistocene; but had died out by the end of the Pliocene.

There were several invasions of elephants into North America. Mammoths had moved across the Bering Land Bridge (Beringia) and by late Pleistocene the woolly mammoth (Mammuthus sp.) was found in North America. Mastodons survived into the postglacial period and Mastodon americanus was one of the most common elephants.

The artiodactyls reached their peak in the Pleistocene with peccaries (Platygonus) quite successful, often living in large herds. Camels had invaded Asia across Beringia, but a large species Camelops persisted through the Pleistocene in North America. Deer of the present day genus Odocoileus had appeared in the Pliocene and flourished during the Pleistocene. The antilocaprid Tetrameryx survived into the period, but had disappeared by the end of the Pleistocene. The pronghorn antelope, (Antilocapra americana) survived and is the only member of the family that lives today (Kurten 1971).

The Bovidae, which evolved in Eurasia, were extremely successful. Only one genus (Bison) invaded the North American Continent across Beringia over 200,000 years ago (Haines 1975). They were extremely successful and continued to flourish until the arrival of white men. By the late Pleistocene many kinds of Bison were present, but Bison bison was the only species that survived to the present.

Sheep and goats also crossed from Asia in the Pleistocene, with big-horned sheep (Ovis canadensis), Dall Sheep (Ovis dalli) and

mountain goat (Oreamnos americana) the three remaining forms.

Carnivores were present in good numbers. A hyaenid (Chasmaporthetes) was present and was the only member of the family that is known to have invaded North America. The ancient hyena-like dogs lived in the early Pleistocene, but by the end of the period only modern types survived. The cats, Felis and Panthera, were present. The dagger-toothed cats were successful during the Pleistocene. They became extinct in mid-Pleistocene, but not before the heavily-built, slow moving Smilodon had evolved. A third felid group was found in North America. Homotherium, which was widely distributed, apparently preyed on juvenile elephants. In the latter portion of the period bears of the modern genus Ursus invaded the continent from Asia. The mustelids were represented by martens and weasels (Mustela). The badger (Taxidea) was present, as were several species of skunks. Otters of the modern day genus (Lutra) were also inhabitants of the Pleistocene.

The ground sloths continued to push northward from South America and were quite successful during the Pleistocene (Kurten 1971).

One of the last mammals to invade North America from Asia was man (Homo sapiens). The exact time of arrival is not clearly known, but it is presently believed that it occurred sometime between 13,700 and 20,000 B.P. Always the invasion by hunting cultures is followed by a sudden decline of the large game, and it is hypothesized that the extinction of large mammals was caused by man's influence. In North America extinction was swift and may have happened within 1000 years. Animals that disappeared were the ground sloth, the giant beaver, Panthera atrox, two species of peccary, one antelope, camel, horse,

dire wolf (Canis dirus) and American mastodon. Of the large species that were present upon man's arrival about 70 percent disappeared shortly after the arrival of Paleo-Indian Tribes. Most that died out were forms that had no previous experience with man, while those mammals that had invaded from Asia continued to survive (Kurten 1971).

It is thought that most of the species of living birds were present by the beginning of the Pleistocene, with evolution since then in characters at the subspecies level. Limited data is available on the avifauna that was present before the Pleistocene, but during that period numerous fossils accumulated at Fossil Lake in Lake County. The species found there are nearly identical with those that are present today. Miller (1911), Howard (1946) and Wetmore (1959) have listed species that have been found and these are presented in Table 5.

Several species that were present in Pleistocene times are now extinct. These include one grebe, one cormorant, one flamingo, one heron, four geese, one duck, three grouse, one coot, two eagles and two gulls. One species, the Elegant Tern has not been known from the area during recorded history, but the Sharp-tailed Grouse has disappeared only within the last 100 years.

TABLE 5

Pleistocene birds from Fossil Lake, Oregon

Western Grebe	<u>Aechmophorus occidentalis</u>
Red-necked Grebe	<u>Podiceps grisegena</u>
Grebe sp.	<u>Podiceps parvus</u>

TABLE 5 (Continued)

	Intermediate in size from
	Eared Grebe and Western Grebe
Horned Grebe	<u>Podiceps auritis</u>
Eared Grebe	<u>Podiceps caspicus</u>
Pied-billed Grebe	<u>Podilymbus podiceps</u>
Cormorant sp.	<u>Phalacrocorax macropus</u>
White Pelican	<u>Pelecanus erythrorhynchos</u>
Flamingo sp.	<u>Phoenicopterus copei</u>
Heron sp.	<u>Ardea paloccidentalis</u>
Trumpeter Swan	<u>Olor buccinator</u>
Canada Goose	<u>Branta canadensis</u>
Goose sp.	<u>Branta propinqua</u>
Goose sp.	<u>Branta hypsibatus</u>
Pygmy Goose	<u>Anabernicula minusaula</u>
Snow Goose	<u>Chen hyperborea</u>
Goose sp.	<u>Anser condoni</u>
White-fronted Goose	<u>Anser albifrons</u>
Duck sp.	<u>Lophodytes cuculatus</u>
Mallard	<u>Anas platyrhynchos</u>
American Wigeon	<u>Anas americana</u>
Green-winged Teal	<u>Anas carolinensis</u>
Blue-winged Teal	<u>Anas discors</u>
Cinnamon Teal	<u>Anas cyanoptera</u>
Northern Shoveler	<u>Anas clypeata</u>
Wood Duck	<u>Aix sponsa</u>
Canvasback	<u>Aythya valisineria</u>

TABLE 5 (Continued)

Barrow's Goldeneye	<u>Bucephala islandica</u>
White-winged Scoter	<u>Melanitta deglandi</u>
Ruddy Duck	<u>Oxyura jamaicensis</u>
Grouse sp.	<u>Tympanuchus palidicinctus</u>
Grouse sp.	<u>Dendragapus gilli</u>
Sharp-tailed Grouse	<u>Pedioecetes phasianellus</u>
Grouse sp.	<u>Pedioecetes nanus</u>
Coot sp.	<u>Fulica minor</u>
American Coot	<u>Fulica americana</u>
Eagle sp.	<u>Aquila pliogryps</u>
Eagle sp.	<u>Aquila sodalis</u>
Marsh Hawk (type)	<u>Circus cyaneus</u>
Greater Yellowlegs	<u>Totanus melanoleucus</u>
Pectorial Sandpiper	<u>Calidris melanotos</u>
Northern Phalarope	<u>Lobipes lobatus</u>
Herring Gull	<u>Larus argentatus</u>
Gull sp.	<u>Larus robustus</u>
California Gull	<u>Larus californicus</u>
Gull sp.	<u>Larus oregonus</u>
Bonaparte's Gull	<u>Larus philadelphia</u>
Sabine's Gull	<u>Xema sabini</u>
Elegant Tern	<u>Thalasseus elegans</u>
Black Tern	<u>Chlidonias niger</u>
Great Horned Owl	<u>Bubo virginianus</u>
Common Raven	<u>Corvus corax</u>
Brewer's Blackbird	<u>Euphagus cyanocephalus</u>

As the large lakes developed after periods of glaciation, Harney Basin became part of the Columbia River system. Malheur and Harney Lakes are the remnants of Lake Malheur. Water flowed eastward from the basin into the Snake River, until late Pleistocene (39,000 years ago - Gehr and Newman 1978) when a lava flow (Voltage Lava Flow) blocked the drainage. Lake Malheur developed after this sudden extrusion of lava. If Lake Malheur ever overflowed this lava plug, or if it changed its drainage into Crane Creek, has not been determined. There is also the possibility that it was never connected to the Snake River System after the Voltage Flow.

Fishes that are present in the Basin today are related to forms that occur in the Columbia River System. Fish species from the Catlow and Warner Valleys suggest that both of these Basins were connected by water to the Harney Basin during earlier pluvial overflows. For a thorough discussion of the origin of the present day fish fauna see Bisson and Bond (1971).

Other than deposits at Fossil Lake little information is available on the fauna that occurred in this region during the Pleistocene. Most mammals that were discussed probably inhabited the region. Remains of horses, camels, sloths, and elephants have been found, but a detailed list of mammals is not available. The Pleistocene was a period of erosion and any deposits have probably been eroded away or covered with sedimentation.

HOLOCENE (10,000 B.P. to recent)

Evidence from Paleo-Indian sites give some indication of climatic

conditions that have existed in the region since 13,000 B.P. The large pluvial lakes still existed 13,000 B.P., but were receding. The mean temperature was 4 to 5° F colder than today's. Precipitation was heavier, averaging over 16 inches. Lodgepole (Pinus contorta) and white pine (Pinus monticola) occupied lower regions and at least in the area of Fort Rock these were the dominant species. Animals were numerous, including now-extinct herbivores. Generally, it was a cool region with abundant precipitation, lakes and forest. Conditions were probably similar throughout southeast Oregon.

By 11,000 or 12,000 B.P. the forests were receding into the higher elevations and open areas were increasing. As open situations increased Bison became numerous and other large herbivores became extinct. Temperatures increased and more arid conditions appeared.

From 7000 to 8000 B.P., arid conditions were becoming more pronounced; after 7000 B.P. truly arid conditions prevailed. Temperatures rose to their highest point between 7000 and 5500 B.P. and precipitation was diminished to 5 inches. The fauna was also reduced in numbers. Lakes, ponds and marshes became dry and streams ceased to flow. Around 7000 B.P. Mount Mazama (present day Crater Lake) erupted, depositing up to 6 inches of pumice in portions of the region. Such an eruption and subsequent ash fallout probably had detrimental effects on the plants and animals, including man. Most fish were probably exterminated in some areas. Around 5500 B.P. the climate moderated and semi-arid conditions returned.

The precipitation rate gradually increased between 4000 and 3000 B.P. and the mean annual temperature declined. About 2840 B.P.

pocket gophers, moles, rabbits, woodrats (Neotoma), ground squirrels, skunks, badgers, coyotes (Canis latrans), deer and antelope were present. This suggests the climate was the same as it is today and has probably been so since 3000 B.P. (Bedwell 1973).

Vegetation was identical to that found in southeast Oregon today; however, species composition has changed. Several species have been introduced, and fires that formerly burned large areas of the northern Great Basin have been eliminated by effective fire control measures. Native grasses have become fire tolerant, while native shrubs, such as sagebrush, have evolved little tolerance. In the Great Basin, fires in late summer and fall, favor cool season perennial grasses which are dormant during the fire season. Thus, the plant composition is different today than it was before settlement by white man. Native peoples have been attributed to setting fires to aid hunting and to control the habitat. There are numerous references of burning from the journals of early day travellers in the Great Basin, and most of these attributed the cause of burning to the native peoples (Shinn 1978). Such fires would be beneficial to the perennial grasses, but detrimental to big sagebrush (Artemisia tridentata). After the arrival of Paleo-Indians grasses were probably more abundant and shrubby species less evident than today.

Modern History

1800 - 1900

Before white settlement of the Malheur-Harney Lakes Basin members of the Wada Eater Band of the Paiute Indians occupied the region. The entire life of the Paiutes was involved with the quest of food, which

was rarely plentiful. Their former habitat extended north to the headwaters of the Silvies River and Silver Creek, south to Catlow Valley. The band wandered as far east as Drewsey, Riverside and the eastern base of Steens Mountain, and on the west to the vicinity of Wagontire.

Around the first of May the band left their winter quarters when the first green plant shoots broke through the ground. Most families moved northeast of Burns to dig roots and trap salmon in the Malheur River. When the salmon run was over families separated to hunt deer, grouse and other birds, and collect different seeds and roots as they ripened. About 15 July families congregated at Cow Creek to gather crickets if they were available. For the remainder of the summer families wandered by themselves, collecting ground squirrels, currants and other berries. Fish were caught in the streams. At this time families often wandered as far north as Seneca and John Day to hunt deer and other mammals.

Around 1 September they returned south to the vicinity of Malheur Lake to gather wada (Suaeda spp.). This was one of the staple seeds and was picked in large quantities. Probably the largest number of people came together at this time. From the lake many families moved into the Warm Spring Mountains to collect chokecherries, which were made into cakes and dried for the winter. Antelope and rabbit drives were also made at this time.

By 1 November, families started to congregate into their winter camps. Sites were selected which had a spring, a good supply of wood and not likely to have a heavy snowfall. Most camps were at

the base of hills, or in protected regions near Malheur Lake. Here, they constructed their houses for winter.

Before 1865 there was not much danger from enemies. After this date raids made it dangerous for families to wander alone and modifications were made in the old way of life (Whiting 1950).

The first white man to enter the Harney Basin was Antoine Syvaille, who with five men trapped the Silvies River in 1825. At this time beaver (Castor canadensis) were reported as common along the river. The following year, in October 1826, Peter Skeen Ogden with a group of trappers arrived on the Silvies River. In the upper stretches of the river beaver trapping success was reported only moderately successful, but as the party progressed south beaver became more plentiful. On 17 October, 134 beavers and one river otter (Lutra canadensis) were trapped for the highest daily total. On this date a member of the Ogden party returned to the camp to report he had followed the Silvies River to its mouth. He reported that once the river left the mountains the area was flat and covered with brush. There the river discharged into a long lake with no outlet. There were other lakes beyond, one of them of salt water (Harney Lake). There were no beaver in the marshes, but the lake did have waterfowl.

At the end of October, Ogden reached the present Malheur marshes and lakes. At the west end of Malheur Lake, Ogden found a small ridge of land an acre in width that divided the freshwater from the salt lake. At the time the two lakes were not connected. There were no signs of beaver, but ancient bison skulls were found. On 2 November the party pushed west of Harney Lake and found several smaller lakes

covered with innumerable swans. From there the group headed west and out of the basin (Binns 1967).

The second party to spend some time in this region was under the leadership of John Work. On 28 June 1831 the expedition moved into Oregon near McDermitt, Nevada. Pronghorn antelope and bighorn sheep were recorded between the border and Mann Lake and also in the vicinity of Mann Lake. On 30 June the party passed Juniper and Ten Cent Lakes and a number of eggs were taken. By 2 July they had reached Malheur Lake. The lake was unusually high and a number of wildfowl was seen. They reached the Silvies River inlet on 3 July. Four antelope were killed near Burns and four beaver were trapped in the river on 4 July; 13 were trapped on 5 July. A mule deer (Odocoileus hemionus) was killed at the same location on 5 July. Twenty-eight miles northwest of this point five beavers and one river otter were taken on 6 July. Also on 6 July a load of young herons were taken in a place where they were very numerous. Two elk (Cervus canadensis) and a mule deer were killed for food on 7 July near the present town of Seneca. On 8 July the party had reached Bear Valley and camped near Scotty Creek, where two beavers were taken. Several antelope were seen crossing the valley. On 9 July an antelope and mule deer were killed as the party was leaving the basin (Haines 1971). Bison were not reported from this region in 1831, but Work's party regularly encountered the species in Idaho. Bison had apparently disappeared from the Harney Basin before 1826 but the number of skulls found by Ogden indicate bison were still in the Basin in the early 1800's.

Little information is available on the ecology of the area after

1831, until Captain Charles E. Bendire arrived at Camp Harney east of the present site of Burns in 1874. Keenly interested in wildlife, Bendire published several papers pertaining to the birds of this region. A member of the U.S. Cavalry, he was stationed at the camp from November 1874 through the spring of 1878. Most species of birds that Bendire recorded still occur in the Basin; however, the status of some have changed.

White Pelicans were breeding in Malheur Lake on several small islands in the east portion, and Bendire collected over 100 eggs in April. Their favorite fishing grounds were at Sod House Spring. The shore swarmed with a species of sucker about 18 inches long. In late May the pelicans had increased and Bendire reported that he could have gathered over a wagon load of eggs. Double-crested Cormorants (Phalacrocorax auritis) were breeding on islands in Malheur Lake in large numbers in the 1870's and also along the Silvies River. The nests were placed on the ground as well as in brush.

Great Blue Herons (Ardea herodias) nested on the same islands with the cormorants and pelicans. Nests were placed in greasewood (Sarcobatus vermiculatus) from 2 to 4 feet above the ground. Another large colony nested in willows along the lower Silvies River in company with other species of herons. No other species of heron nested on the islands in Malheur Lake. The Great Egret (Casmerodius albus) was a common summer resident in the thick willows on the lower Silvies River. The colony was located about 15 miles south of Camp Harney and consisted of about 300 or more nests. Snowy Egrets (Egretta thula) were also nesting in this colony. Black-crowned Night

Hérons (Nycticorax nycticorax) were extremely common in the lower Silvies River colony, where their nests were placed low in the willows, not more than 3 feet from the ground. The White-faced Ibis (Plegadis chihi) was not recorded by Bendire in Oregon; however, he did report on a colony nesting near Quinn River Crossing, Nevada, 20 miles south of the Oregon border. About 40 birds were seen on 15 July 1875 with young that were still unable to fly. Least Bitterns (Ixobrychus exilis) were considered rare and American Bitterns (Botaurus lentiginosus) were common summer residents in the marshes throughout the country, even in the mountains.

Whistling Swans (Olor columbianus) were very common on the borders of Malheur Lake and a few remained through 24 April. A Trumpeter Swan was also recorded. Both Snow and White-fronted Geese were common in migration, but the Ross' Goose (Chen rossii) was considered rare. Several Canada Geese nested on the islands in Malheur Lake in 1875. The Black Brant (Branta nigricans) was considered by Bendire to be migratory and rather uncommon in the Basin. He stated that several were seen in the hands of Indians.

The status of ducks were as follows: Mallards bred abundantly; Pintails (Anas acuta) did not remain to breed, but were common in migration; Gadwalls (Anas strepera) were very common summer residents and fresh eggs were found as late as 20 July; American Wigeon were a rather common summer resident and were found breeding at several locations; Green-winged Teal were equally common and bred, but seemed to be more partial to the smaller mountain streams than the larger bodies of water in the valley during the breeding season; Blue-winged

Teal were not so common and it was doubtful that any bred; Cinnamon Teal were more common than the other teal, breeding in large numbers; Wood Ducks (Aix sponsa) were very rare; Greater Scaup (Aythya marila) were very common during migration as was the Lesser Scaup (Aythya affinis); the Ring-necked Duck (Aythya collaris) was not so common as either of the scaups during migrations and was more often found in the deeper portions of the lakes than in the creeks and sloughs; Redheads (Aythya americana) were common in migration and probably a few nested while Canvasbacks were equally common during migration and bred in the higher valleys of the Blue Mountains. The Common Goldeneye (Bucephala clangula) and Bufflehead (Bucephala albeola) were common in the open portions of Malheur Lake. Common Mergansers (Mergus merganser) were common in migration along mountain streams; Red-breasted Mergansers (Mergus serrator) were believed breeding along Bear Creek near present day Seneca, where it was common in August 1876; the Hooded Merganser (Lophodytes cucullatus) was the most common of the mergansers.

Swainson's Hawks (Buteo swainsoni) were common summer residents, and nested in willows along the streams and in isolated juniper and pine trees. The Red-tailed Hawk (Buteo jamaicensis) nested in pines and in the larger willows along the Silvies River near the different heronies located along the stream. The Ferruginous Hawk (Buteo regalis) was rather rare, but was more common near McDermitt, Nevada where it bred. Rough-legged Hawks (Buteo lagopus) were irregular winter visitors, common in some seasons and entirely absent in others, feeding principally on cottontail rabbits (Sylvilagus nuttalli). An

unusual record was the breeding of the Red-shouldered Hawk (Buteo lineatus). Eggs were collected on 6 May 1878 near Camp Harney and a female was also apparently collected (Browning 1973). The Golden Eagle (Aquila chrysaetos) was moderately abundant throughout the year, while the Bald Eagle (Haliaeetus leucocephalus) was not nearly so common, but one pair did nest on the Silvies River. Turkey Vultures (Cathartes aura) were common in the summer. The Peregrine Falcon (Falco peregrinus) was seen near Malheur Lake where it was attracted by the large number of waterfowl. A set of eggs was taken by Bendire near Malheur Lake on 24 April 1877 (Gabrielson and Jewett 1940). The Prairie Falcon (Falco mexicanus) was common during waterfowl migration and a few nested in the vicinity. A nest of the Merlin (Falco columbarius) was found in May 1876 in the Blue Mountains, and the American Kestrel (Falco sparverius) was a very common summer resident. The Osprey (Pandion haliaetus) was considered a rare summer visitor and a pair nested annually on the lower Silvies River.

The Sage Grouse (Centrocercus urophasianus) was common in the upper Silvies Valley and during the winter the species moved into Harney Valley. The Sharp-tailed Grouse was a moderately common resident, but was apparently irregularly distributed. It was found mainly in juniper groves in the winter.

Greater Sandhill Cranes (Grus canadensis tabida) were common summer residents. They nested in the lowlands as well as in the highest mountain valleys. The American Coot was found in large numbers on Malheur Lake where the species nested.

The American Avocet (Recurvirostra americana) was an abundant

summer resident, breeding near Malheur Lake and along the shores of Silvies River. Black-necked Stilts (Himantopus mexicanus) frequented the same locations, but the species was not as common as the avocets. Wilson's Phalaropes (Steganopus tricolor) were moderately common summer residents, but the Common Snipe (Capella gallinago) was considered rare. Willets (Catoptrophorus semipalmatus) were abundant summer residents, and Long-billed Curlews (Numenius americanus) were common and bred abundantly. Most migrant shorebirds were considered abundant.

The Burrowing Owl (Speotyto cunicularia) was a common summer resident and the Great Horned Owl (Bubo virginianus) was common. The Short-eared Owl (Asio flammeus) was not nearly as common as the Long-eared Owl (Asio otus).

The Mourning Doves (Zenaida macroura) were an abundant summer resident, and they nested both in trees and on the ground. Barn Swallows (Hirundo rustica) were rather rare, but a few pairs nested about the buildings at Camp Harney (Bendire 1877).

Since recorded history Malheur and Harney Lakes have not always been joined. In 1826, Ogden reported a small ridge divided the two lakes, but in 1864 a channel connected the two. In the 1870's the drain seems to have been closed by an extensive "sand reef", over which cattle were driven to avoid going around the lakes. About 1880 Malheur Lake overflowed the reef into Harney Lake and the present "sand gap" was created (Piper et al. 1939).

In the 1850's miners from California crossed the region heading for Idaho. Although they left little information on the ecology of

the basin, they did report well-watered valleys, grassy hills and an abundance of game. However, these reports eventually had an effect on the ecology of the area, as they attracted stockmen to the region from the valleys of California and the eastern United States. Upon their arrival much of the region was covered with bunchgrasses. Lesperance et al. (1978) reported that along the Humboldt River drainage in northern Nevada Great Basin wildrye (Elymus cinereus) comprised 10 percent of the area during pristine times. Probably similar conditions occurred in the Harney Basin. Vale (1975) reviewed 29 journals of early day travellers and reported on the vegetation before the arrival of stockmen. The pristine vegetation was dominated by shrubs. Stands of grass were usually confined to wet valley bottoms, moist canyons and mountain slopes. Vale further reported that grazing has caused an increase in the density of brush in many areas, but woody shrubs were an important and perhaps dominant component of the ranges under pristine conditions.

During the decade of the 1860's cattlemen began using eastern Oregon for grazing purposes. By 1868 settlement of southeast Oregon had begun. In the 1870's areas in this region were beginning to suffer from overgrazing. Severe weather in the winter of 1889-90 caused thousands of cattle to perish on the open range.

Through the 1870's Steens Mountain was covered with bunchgrass, but the area suffered some of the most severe overgrazing in Oregon. By 1924 the mountain was considered worthless by stockmen. After the winter of 1889-90 there were 56,699 sheep in Harney County. By 1901, 73 bands of sheep occupied Steens Mountain with each band containing about 2500 animals (Shinn 1978).

Western junipers increased at this time. It has been proposed that if land is subjected to fire more than once every 15 years junipers will be eliminated. With fire suppression after settlement junipers increased. In addition, untimely grazing damaged herbaceous and bunchgrass populations when they were cropped during critical periods of spring growth. This favored shrub populations by reducing the competitive capacity of grasses (Shinn 1978).

Following white settlement introduced plants made their appearance. One of the most prolific species to invade was cheatgrass (Bromus tectorum). This introduced annual appeared in the western United States in the 1890's and now occupies large regions of the intermountain west (Vallentine 1971). The plant grows well on disturbed sites, especially in overgrazed areas. It is now one of the most common species in the Harney Basin.

The plume hunters came into the region around 1900 to slaughter swans, grebes, egrets and other birds for the millinery trade. Egrets were nearly exterminated by this practice and the tern and grebe colonies were greatly reduced. Fur trappers were also using the Basin at this time, taking thousands of beaver, muskrat (Ondatra zibethica) mink (Mustela visons) and otter.

As the last century of this report came to a close, the ecology of the Malheur-Harney Lake Basin was rapidly changing. White settlement was in the process of altering the region, which would have impacts on the flora and fauna. A continuation of the ecological history from 1900 through 1978 will be discussed in a separate report.

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SUMMARY

The Malheur-Harney Lake Basin lies at the northern extremity of the Great Basin. Presently the land is characterized by sagebrush and junipers, with numerous basaltic rimrocks.

The climate is semi-arid, but it has not always been that way. About 54 million years ago the Basin was covered with tropical forest. Sedimentation from the Blue Mountains had established lowlands, and the Coast Range and Cascade Mountains had not been up-lifted. With no mountain barriers, an oceanic influence prevailed throughout present-day eastern Oregon. Coniferous forests were absent and there were no members of the tree families that are common in Oregon today. The climate was warm, with heavy rainfall and no freezing temperatures. Climate and vegetation was much like that which is found today in Panama.

Persea, of the laurel family, was the most evident, but the flora also contained cinnamon, figs, ancestors of the sycamores, tropical ferns, palms and a Cycad. Most of these plant's nearest relatives now survive in southeast Asia and Central America.

Little information is available on the animals that lived in the area during this time. Thus far, the region has yielded crocodiles, fish, a small horse, rhinoceros, tapir, oreodont and titanothere, but other faunal information is lacking.

The tropical climate continued to persist until about 30 million years ago, when there was a return to a more temperate climate. With cooling temperatures, the tropical forest of the low plains was replaced by a temperate forest. Most of these species probably migrated down the slopes of the Blue Mountain highlands where temperatures had been cool enough for them to persist through the Eocene (54 - 38 million years ago). Other genera and species may have migrated south from British Columbia and Alaska where the original temperate boreal forest had flourished through the previous 25 million years.

Data is again limited on the animal life that was in the region during this epoch. Rhinocerus teeth and an oreodont skull have been found, as well as one quail leg.

The tendency toward a cooler and drier climate continued for the next 20 million years. The continent was still drifting toward the northwest, but a more local factor that had a profound effect upon the climate was the volcanic activity which was building the Cascade Mountains.

From about 20 to 7 million years ago ecological conditions were variable, with open woodlands existing adjacent to the open grassland plains which had become evident during this time period. There were small lakes, streams and floodplains (or even swampy areas), with woody areas, at least in the valleys. Many plant genera that are present today in the eastern and western United States, and in Asia, were present here during this 19 million year epoch.

Many families of mammals that are present today were well represented by the early Miocene (26 to 20 million years ago). Rodents

were characterized by two arboreal species of squirrels. Mountain beavers were represented by several species. Although reduced to a single form today (Aplodontia rufa of the Pacific Northwest), the family did achieve a modest success during this epoch. Relatives of the beaver, small rodents and rabbits were all present. Larger mammals included numerous horses, rhinoceroses, primitive swines, peccaries, oreodonts, camels, canids, cats, elephants and antelope.

As the epoch was coming to an end, geologic changes were taking place. Extensive lava flows were covering the lowlands, but left mountainous areas exposed. Locally, Steens basalt extended westward to Paisley, Oregon and eastward past the Trout Creek and Sheephead Mountains. This basalt flow had its maximum depth of 4000 to 4500 feet on Steens Mountain, but along the periphery flows were shallow. Lava flows of this magnitude surely had a catastrophic influence on the flora and fauna of this region.

Beginning 7 million years ago, precipitation had been reduced to 20 to 23 inches annually and temperatures had lowered to an average of 57° to 58° F. The Coast Range and Cascade Mountains had been elevated to their present elevation. Modern ranges and basins were well established 5 million years ago. Woodlands and forest only occurred along streams and at higher elevations, with savanna and open grasslands occupying much of the area. Annual precipitation had been further reduced to 15 to 17 inches.

Mountain beaver were still present, along with several other genera of small rodents. Three genera that were present 7 to 3 million years ago are identical to those that occur today (marmots, Ground squirrels, white-footed mice). Rabbits were represented by

two genera, including Lepus, which is the genus that is presently found in southeast Oregon.

Elephants, which had arrived in the Miocene, were apparently abundant in the Pliocene (7 to 3 million years ago). Horses, rhinoceroses, peccaries, oreodonts, camels, antelope, ground sloths, canids, martens, badgers, otters and cats were all inhabitants of southeast Oregon.

Before the Pliocene, few bird fossils had been found. However, several fossil species have been located that were present at this time. These include a cormorant, herons, a flamingo, a goose, ducks, an accipter hawk and a coot.

By late Pliocene, a widespread climatic change took place, which initiated a return to more moist and cooler conditions leading to the ice age. Although the Coast Range and Cascade Mountains still acted as a barrier to moisture from the Pacific Ocean, the lower temperatures and consequent lower evaporation rates may have resulted in a greater effective precipitation. The Pliocene was the climax of the age of mammals before the coming of the cold. A survey of mammal families by the end of the epoch showed that some extinction had already begun.

The Pleistocene epoch began 3 million years ago and ended about 10,000 B.P. During the epoch four advances of the ice sheet moved south into the northern United States, and extended further southward into the mountain ranges. These glacial periods were presumably separated by warm periods. As the glaciers retreated from Steens Mountain and other mountain ranges, excessive run-off produced large

bodies of water within the Great Basin. Lake Malheur was the third largest of these lakes and covered 920 square miles with depths to 70 feet. It is assumed that the pattern of vegetation adjusted to the conditions of either advancing or retreating glaciers. Most of the plant species had evolved into the forms that occur in the region today. During periods of glaciation the boreal forest may have occupied the plateau south of the ice sheet into the northern Great Basin. As the glaciers retreated true grasses, composites and chenopods moved in and replaced the forest.

During the ice age, the seas were receding and the continents became joined by land bridges, with land animals migrating from continent to continent. Little information is available on species that were present in southeast Oregon in the early Pleistocene, but by the close of the epoch, forms that inhabit the region today were present. Horses were still found, but they soon died out. Tapirs continued to survive, but also gradually died out. Rhinos did not live into the Pleistocene, but had disappeared by the end of the Pliocene. There were several invasions of elephants and by the end of the epoch woolly mammoths were present. Peccaries, camels, a hyenid, ground sloths and several species of cats also probably occurred in this region.

In addition, several genera had migrated across the Bering Land Bridge. These included sheep, goats, bears and buffalo. One genus of bison (Bison) invaded the North American Continent over 200,000 years ago. They were extremely successful and continued to flourish until the arrival of white men. By the late Pleistocene many kinds

of Bison were present, but Bison bison was the only species that was able to survive to the present time.

One of the last mammals to invade North America from Asia was man. The exact time of arrival is not clearly known, but it is presently believed that it occurred sometime between 13,700 and 20,000 B.P. Always the invasion by hunting cultures is followed by a sudden decline of the large game, and it is believed that the extinction of large mammals was caused by man's influence. In North America, extinction for some species was swift and may have happened within 1000 years. Animals that disappeared were the ground sloth, the giant beaver, cats, peccaries, one antelope, camel, horse, dire wolf and American mastodon. Of the large species that were present upon man's invasion, 70 percent disappeared shortly after the arrival of Paleo-Indian Tribes. Most that died out were forms that had no previous experience with man.

It is thought that most species of living birds were present by the beginning of the Pleistocene, with evolution since then in characters at the subspecies level. Several known species that were present in the epoch are now extinct. These include one grebe, one cormorant, one flamingo, one heron, four geese, one duck, three grouse, one coot, two eagles and two gulls. One species that was present was the Elegant Tern, which has not been known from the area during recorded history. By 13,000 B.P. the large pluvial lakes still existed, but were receding. The mean temperature was 4 to 5° F colder than presently and precipitation was heavier, averaging over 16 inches. Lodgepole and white pines occupied lower regions. Animals were numerous, including now-extinct herbivores.

By 11,000 or 12,000 B.P. the forests were receding into the higher elevations and open grassy areas were increasing. From 7000 to 8000 B.P., arid conditions were becoming more pronounced, however, truly arid conditions did not develop until after 7000 B.P. Temperatures reached their high between 5500 and 7000 B.P. and precipitation was diminished to 5 inches. The fauna was also reduced in numbers. Lakes, ponds and marshes became dry and streams ceased to flow. Around 7000 B.P. Mount Mazama (present-day Crater Lake) erupted, depositing up to 6 inches of pumice in portions of the region. Such an eruption and subsequent ash fallout probably had detrimental effects on the plants and animals, including man.

The precipitation rate gradually increased between 4000 and 3000 B.P., and the mean annual temperature declined. By 3000 B.P. the climate and vegetation was probably the same as it is today in southeast Oregon. However, species composition has changed. Several plants have been introduced, and fires that formerly burned large areas of the Northern Great Basin have been eliminated by effective fire control. Native peoples have been attributed to setting fires to aid hunting and to control the habitat. There are numerous references of burning from the early day travellers in the Great Basin, and most of these attributed the cause of burning to the native peoples. Such fires were beneficial to the perennial grasses, but detrimental to big sagebrush. Since the arrival of Paleo-Indians grasses were probably more abundant and shrubby species less evident than today.

The first white men to enter the Malheur-Harney Lakes Basin were a group of trappers that discovered the Silvies River in 1825. The following year, in October, 1826, Peter Skeen Ogden with a party of trappers arrived at Malheur and Harney Lakes. Nothing further was reported from the region until June, 1831 when another group of trappers crossed the Basin from McDermitt, Nevada, and the Alvord Desert, to Malheur Lake and Seneca.

Little additional information is available on the ecology of the region until 1874, when Capt. Charles E. Bendire arrived at Camp Harney, 10 miles east of Burns. Keenly interested in wildlife, he published several papers pertaining to the birds in this area. Most species of birds that Bendire recorded still occur in the Basin; however, the status of some have changed. Red-shouldered Hawks and Columbian Sharp-tailed Grouse were breeding birds at the time, but they have since disappeared. Barn Swallows were considered rare, but are now an abundant summer resident. White Pelicans were nesting commonly on Malheur Lake. Many other species that are here today were present in Bendire's time, but their numbers have been reduced.

In the 1850's miners from California crossed the Basin heading for Idaho. Although they left little information on the ecology of the region, they did report well-watered valleys, grassy hills and an abundance of game. However, these reports did have an effect on the ecology of the area, as they attracted stockmen to the region. During the 1860's, cattlemen began using eastern Oregon for grazing purposes. By 1868, settlement of southeast Oregon had begun. By the 1870's areas in the region were already beginning to suffer from overgrazing.

The plume hunters came into the region around 1900 to slaughter swans, grebes, egrets and other birds for the millinery trade. Egrets were nearly exterminated by this practice and the tern and grebe colonies were greatly reduced. Plume hunters continued to harvest birds until Malheur and Harney Lakes were established as a bird reservation on 18 August 1908. By 1911, the only known nesting colony was abandoned and only one Great Egret was seen in the Basin. In 1918, the species was found again nesting in Malheur Lake. Snowy Egrets were no longer seen and had apparently been exterminated.

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1900 - 1935

Plume hunters continued to harvest birds until Malheur and Harney Lakes were established as a bird reservation by the Special Executive Order of President Theodore Roosevelt on 18 August 1908 (Finley and Finley 1936).

In 1911, the depth of Malheur Lake was about 18 inches and waterfowl food plants were in abundance. Eared Grebes were nesting in large numbers and waterfowl were abundant. At Silver Lake, an estimated 40 Great Egrets were nesting on a small island (Refuge Narrative Report - 1911).

Cinnamon Teal and Ruddy Ducks were the most conspicuous species on Malheur Lake in 1915, and Redheads were numerous. There were an estimated 100,000 coots using the lake and about 500 White Pelicans nested on drift material. About 300 Great Blue Herons were nesting in hardstem bulrush, as were 150 pairs of Double-crested Cormorants. In the 1870's, these two species were nesting with White Pelicans on islands in Malheur Lake, but in the intervening 40 years their nesting habitat preferences had changed, or the islands no longer provided suitable nesting sites. A few Long-eared Owls continued to nest in the willows, and Short-eared Owls were becoming more common.

Malheur Lake was low in 1916 as more water was being diverted from the Silvies and Blitzen Rivers to private lands north and south of the refuge. The Great Egrets had abandoned the nesting colony on Silver Lake. Ground squirrels were increasing, ^{because of} after a reduction in coyote numbers after an outbreak of rabies in 1915. Swainson's Hawks were common, feeding on the numerous squirrels.

Cinnamon Teal and Shovelers were plentiful during the nesting season, but coots had declined in numbers from the preceding year. White Pelicans were estimated at 800 birds in the nesting colony, and ^{as} ~~like~~ in the 1870's the species was using Sod House Spring for feeding purposes. About 200 pairs of cormorants were also nesting. Mallards and Gadwalls were using the middle of Malheur Lake for nesting purposes and Ruddy Ducks were still numerous.

Black-crowned Night Herons were nesting in the hardstem bulrush, where 200 birds were estimated. Only one Great Egret was seen in 1916. About 200 Caspian Terns were using the lake and were probably breeding (Refuge files).

After Bendire's work in the 1870's no published information was available on Malheur Lake until ^{George} Willett (1919) investigated the avifauna in the summer of 1918. Western Grebes were nesting abundantly, and there were three observations of the Horned Grebes (Podiceps auritis). On An Estimated 6000 pairs of Eared Grebes were also present. Sixty pairs of California Gulls and 500 pairs of Ring-billed Gulls were nesting on Pelican Island, as were 100 pairs of Caspian Terns. In the broken down tules (hardstem bulrush) 100 pairs of cormorants, 400 pairs of White Pelicans and 600 pairs of Great Blue Herons nested.

The status of waterfowl was as follows: Canada geese were using muskrat houses and broken down tules for nest sites; Mallards nested abundantly in hay fields both on and off the refuge, with the most common nesting habitat in long grasses; Gadwalls were probably nearly as common as the preceding species; American Wigeon were not seen in the summer; Green-winged Teal were first noted on 31 July and became

common in August; only one Blue-winged Teal was identified; Cinnamon Teal was an abundant nesting species; Shovelers bred in small numbers; Pintails were occasionally seen during the summer and a few probably nested; ^{and} the Redhead breed abundantly in the tules on Malheur Lake. ^T the two species of scaup were not separated by Willett, but he did note that scaup were fairly common in spring and fall migration; Common Goldeneyes were noted several times on the Blitzen River in late April and early May; Buffleheads were fairly common in spring; Ruddy Ducks bred abundantly in the tules at Malheur Lake, generally fairly close to open water and several nests were located on muskrat houses; and Common Mergansers were noted several times in late April and early May.

P About 100 pairs of White-faced Ibis nested in the lake and Great Egrets were nesting in the tules about 3 miles east of the Blitzen River inlet. About 20 pairs were located. Nearly 500 pairs of Black-crowned Night Herons were nesting along the west side of the lake, along with Great Blue Herons and Ibis. The saltgrass ^(Distichlis stricta) flats along the east and south sides of the lake were the favorite nesting grounds for the American Avocet, and the species was considered abundant. Black-necked Stilts were not seen, however, one pair was known to have nested between Burns and the refuge. ^{Western} Willets were breeding in the same region, but non bred around Malheur Lake, and Long-billed Curlews were common on the wet meadows in the Harney Valley. Ring-necked Pheasants were fairly common in the vicinity of Burns after the species was introduced in 1913. Marsh Hawks were plentiful around Malheur Lake, but the Red-tailed Hawk was rare. Prairie Falcons breed plentifully in the hills that surrounded Harney Valley and the Peregrine Falcon was fairly common in August.

The Short-eared Owl was a common breeding species, while the Great Horned Owl was generally common. In the fields bordering Malheur Lake the Burrowing Owl was rather common.

Bobolinks () were common around Malheur Lake, and By 1918 the Barn Swallow was nesting commonly under the bridges in many parts of Harney Valley.

In 1918, Willett reported that many nests of ducks were destroyed by predators, mainly ravens and skunks. Careful observation showed that 50 percent of all duck nests were lost.

Although Malheur Lake had been set aside by the federal government as a bird reservation, ^{there was} little control of grazing, water supplies and mowing activities ~~occurred~~ ¹ from 1908 through 1935. The driest year in recorded history was in 1918, and most of the refuge was mowed by local stockmen.

Run-off in 1922 was higher than ⁱⁿ any year since 1917. There was a steady flow from the Silvies and Blitzen Rivers and by June water was running from Malheur Lake through the Narrows. Both Western and Eared Grebes were still nesting abundantly. Forster's Terns possibly outnumbered all other species, except blackbirds. About 50 pairs of cormorants were nesting in broken down tules, along with Great Blue Herons. Four hundred pairs of pelicans placed their nests in tules on Cole Island.

Mallards nested abundantly and Gadwalls were equally or more abundant. This species and the Cinnamon Teal were the most abundant waterfowl in the Harney Valley. Canvasbacks were rare, but the Redhead's status was abundant.

White-faced Ibis were more abundant and 400 were seen on 11 and 12 June. Large colonies of Great Blue Herons were on Cole Island during the summer. Eighty Great Egrets were nesting in a colony on the Island Ranch, north of the reservation. These willows were rapidly being destroyed by the weight of their nests. No egrets were known to have nested among the tules in Malheur Lake. Black-crowned Night Heron numbers were estimated between 500 and 600 pairs, with the species nesting in the broken down tules on Cole Island and on tule islands in east Malheur Lake.

American Avocets were still breeding abundantly around the lake and Black-necked Stilts had increased. The Swainson's Hawk was the most common large hawk in the Basin, and the species nested in the juniper trees bordering the valley. The Burrowing Owl was rather common in the sagebrush flats. Common Ravens were increasing, ^{by an estimated 2500 %.} ~~and where there used to be one there~~ ^{were} ~~now 25.~~ The Barn Swallow was by now a very abundant breeding species, nesting in the interior of barns and under porches of houses throughout the valley (Refuge files).

~~During this 35 year period~~ the once plentiful bighorn sheep was last reported on Steens Mountain in 1911. The species formerly occupied all of the rimrocks in the Basin, and were even common in the desert lowlands. Elk were more widespread and ^{their} antlers and bones were ^{found} located near Burns and in Malheur Lake. They were seen near the lake in the late 1800's. An estimated 1200 pronghorn antelope were using the region in 1916.

In 1916 a few mountain lions (Felis concolor) were seen on Steens Mountain and a Canada lynx (Felis canadensis), which was considered

scarce in Oregon, was collected along Kiger Creek on, or near Steens Mountain. In the early days the Blue Mountains supported a few lynx, and the animal that was killed was probably a wanderer from that region. The red fox (Vulpes fulva) was present in the valleys on Steens Mountain and the Blue Mountains in 1920, but the species soon disappeared. In the Malheur Lake bed numerous buffalo skulls were found. Also ~~Elk antlers~~, and the skull of a grizzly bear (Ursus horribilis) ^{was also} found, indicating that ~~both of these~~ ^{this} species once occurred in the Basin lowlands (Bailey 1936). ^{degradation}

In 1922 the coyote was not a serious factor in the Harney Valley. However, during the fall and winter the species moved into the valley and killed a considerable number of muskrats (Refuge files).

For 25 years the controversy continued on who owned Malheur Lake -- the federal government or the state of Oregon. It was not until October 1934 that the case was finally settled in court, and the federal government was declared the rightful owner. Unfortunately, through the 1920's and 1930's the lake continued to be abused. Drought conditions persisted through the early 1930's, and what little water was available in the Basin was diverted ^{in the} in the Blitzen Valley and in the meadows south and east of Burns. By 1934 Malheur Lake had dried completely. Homesteaders followed the waterline onto the refuge and began farming the lake bed. Also, unrestricted grazing occurred on the lake from 1928 through 1937. Wind storms were prevalent at these times and the valley was often enveloped in dust.

1935 - 1950

In 1935 the P-Ranch was purchased outright by the federal government so that a permanent water supply would be assured to Malheur Lake.

This ranch encompassed the entire Blitzen Valley. Added to the area that had been established as a refuge in 1908, the total ^{area of the refuge} ~~acreage~~ became 164,000^{acres}. In 1936, Malheur Lake once again had water.

Temperatures were cold during the winter of 1936-37 and some upland game birds ^{populations} were decimated. Both Mountain () and California Quail () populations were completely destroyed. Ruffed Grouse (), which had been introduced in 1936, were also eliminated. Sage Grouse numbers were reduced, but Gray Partridge () and Ring-necked Pheasants wintered well.

The creation of lagoons, ponds, dikes and canals in the Blitzen Valley attracted a number of breeding ducks. Canvasbacks were found nesting in the summer of 1937 near the P-Ranch, establishing the first breeding record for the refuge.

Striped skunks (Mephitis mephitis) and bobcats (Felis rufus) were evident during the year. Both mule deer and pronghorn antelope were common within the refuge boundaries and in the surrounding regions.

By 1938 water conditions were the best since 1928, providing excellent habitat for waterfowl, marshbirds and shorebirds. The first nesting record of Lesser Scaup occurred and Canvasbacks were increasing. Gadwalls were the number one nesting ducks. Gulls, pelicans and terns nested on old sunken haystacks in Malheur Lake. Pelicans and gulls started using the stacks in 1936 after being absent as nesting species

since 1926. Ring-necked Pheasants were increasing, but the exotic Gray Partridge was barely holding its own.

Predator control practices were initiated and 76 ravens, 14 Common Crows () and 11 Black-billed Magpies were destroyed in June. A summation of predator control on the refuge is presented in Appendix A. Efforts to stabilize the local livestock industry were also begun after the purchase of the Blitzen Valley. In 1938, 34,000(?) A.U.M.'s of grazing occurred, and 7,140 tons of hay were harvested. The total A.U.M.'s for subsequent years is presented in Appendix B.

An increase in shorebirds was noted in 1939, and waterfowl showed minor increases. From 25 July through 7 October a botulism outbreak occurred on Malheur Lake, and 20,000 birds died from the disease. Great Egrets were increasing and 107 were seen on the lake on 17 August. Trumpeter Swans were re-introduced, as was the California Quail. Both muskrats and beaver had increased.

Muskrat houses in 1939 showed a 1000 percent increase over 1938, and an estimated 6000 were present in Malheur Lake. Mule deer were abundant on Steens Mountain and the range was becoming severely abused. Even the junipers were being over-grazed.

Canada Geese had increased since 1935, and by 1940 there were about 2000 pairs nesting on the refuge. These pairs produced an estimated 6000 young, and ducks produced an estimated 50,000 young. A nest of the Snowy Egret was found in late June for the first record since the plume hunting days of the early 1900's.

R Muskrats had increased to 24,500 on Malheur Lake and emergent vegetation had been greatly reduced from the activities of these rodents. A "crash"

in their population occurred in March 1941, and many were found in the desert flats, miles from water. Seventeen were removed at one time from a cattle guard near Malheur NWR headquarters.

By the summer of 1941 water conditions were the best they had been since the Blitzen Valley was purchased. An estimated 75,000 ducks were produced. A check of 844 duck broods averaged 7.5 young per brood. Mallards, Gadwalls and Pintails were the three leading species, and Redheads were showing a marked increase. Blue-winged Teal was now considered a rare nester. Seven additional Trumpeter Swans were released on the refuge.

Because of disintegration of the sunken haystacks in Malheur Lake, White Pelicans moved to dead tule mats to nest. However, strong winds during the incubation period resulted in the loss of this colony. Snowy Egrets increased to three pairs.

Muskrat numbers continued high even after the spring "crash", and mink and weasels increased. Antelope were also increasing, as were mule deer. No livestock grazing occurred in the Blitzen Valley, except for 140 cattle which accrued 5700 A.U.M.'s.

Large rainbow trout (Salmo gairdneri) were evident in the Blitzen Valley as far north as Boca Lake.

In the fall of 1941 water conditions remained excellent and Boca Lake was running over. Harney Lake contained substantial water after a good early flow from Silver Creek and heavy summer rains. On 3 July 1941 the federal government purchased the Double-O Ranch, west of Harney Lake, and this became a part of Malheur NWR.

California Quail numbers were again reduced from severe winter conditions in 1942. Mule deer suffered a 10 percent loss on Steens Mountain, and antelope were forced into the lowlands, and the species became prevalent at Double-O, Harney Lake and south of Boca Lake. Muskrats continued to show little decline, and emergent vegetation in Malheur Lake was further reduced. After beaver populations had increased for several years, an undetermined disease took its toll. Tularemia was suspected.

Water conditions remained good through 1943. The Trumpeter Swans that had been re-introduced had apparently left the Basin, or died, as no additional observations were made. Seven Great Blue Herons nested for the first time at Benson Boat Landing north of refuge headquarters. The first state record of the Starling (Sturnus vulgaris) occurred at the refuge on 24 December 1943. This exotic species was later to become an abundant nester, at the expense of other cavity-nesting small birds. In the fall, Ring-necked Pheasants reached their highest number on record. An estimated 5500 were in the Blitzen Valley.

An elk was seen on Malheur Lake for the first lowland record since white settlement of the Basin. Mule deer were still abundant on Steens Mountain, and one hunting camp that was checked contained 108 deer.

Drought conditions returned in 1944 and range conditions were exceptionally poor by April. However, antelope continued to increase, and local stockmen and farmers were becoming concerned that their increase would eventually conflict with their ranching operations. Muskrat populations became reduced and emergent vegetation rapidly became dense. The disease that had effected beaver in 1943 subsided,

and the species was once again becoming numerous. Both rabbit and rodent populations were low. In 1944, it became apparent that the raccoon (Procyon lotor) was increasing tremendously.

Rough-legged Hawks were very numerous in January and February, and Swainson's Hawks were very common in the spring. Many Swainson's Hawks were now using big sagebrush for nesting sites. Mallards were the number one nesting species of waterfowl. Common Merganser were much more common and it was estimated that 500 were using the Blitzen Valley during the nesting season.

Pelicans were nesting on Cole Island Dike, along with cormorants. In addition, the latter species was nesting at Boca Lake. Approximately 1500 Black-crowned Night Herons and 100 Great Blue Herons were nesting among the emergents in Malheur Lake. The Gray Partridge had become extremely scarce, but California Quail were increasing.

Antelope started to decline in 1945, and only 51 could be located in Catlow Valley, where normally 700 to 800 were found.

In 1946, Gadwalls became the number one waterfowl nesting species and Mallards had dropped to second. There was a slight increase in Blue-winged Teal. This species had increased in the Basin by ten-fold since 1936. On 25 July, an estimated 500 duck broods were on Boca Lake. No pelicans or cormorants were known to have nested in 1946, but on the southwest side of Malheur Lake 125 pairs of Great Blue Herons, 300 pairs of Great Egrets, 60 pairs of Snowy Egrets, 1200 pairs of Black-crowned Night Herons and 2 pairs of White-faced Ibis nested. American Coots had an outstanding season and it was estimated 500,000 young were produced. Twenty Caspian Terns and 2500 gulls nested on an

island in southwest Harney Lake.

In 1946 and 1947 water supplies were below normal in the Basin, especially those that had headwaters on Steens Mountain. Redheads and Canvasbacks were reduced in numbers on Malheur Lake and Mallards were reduced by 25 percent in 1947. An estimated 4000 young Canada Geese were produced. Pelicans again did not nest, but cormorants moved into the north portion of Malheur Lake and nested. By late April, 80 pairs of Black-crowned Night Herons were nesting west of Cole Island Dike.

Antelope showed an increase in the Basin after their numbers declined in the mid-1940's, while mule deer numbers had remained stable through this period. A female elk summered near the north end of Cole Island Dike and a male was seen on Wright's Point. Beaver numbers declined after a steady buildup for 3 years. Coyote numbers were at low levels throughout the Basin.

Water conditions in 1948 had improved, and were comparable to the levels in 1945. Canada Geese had excellent nesting success at 85.9 percent, while Mallards showed 42.9 percent, Gadwalls 80 percent and Redheads 55.5 percent. Whistling Swans had continued to increase in the Basin and in 1947, 10,000 were concentrated on Malheur Lake in November.

Franklin's Gulls () which had first appeared in Oregon in 1943, had continued to increase and 60 were estimated in the Basin in 1948. Their first Oregon nest was found in Malheur Lake in June. Greater Sandhill Cranes had been increasing during the early and mid-1940's and this trend was continuing.

Musk rats increased, and their numbers were nearly double those of 1947. Raccoons were now common in the lowlands of the Basin. Black-tailed jackrabbit and cottontail numbers were building, as were those of small rodents. Pocket gophers were at a peak and meadow voles (Microtis montanus) built-up early, but a late winter die-off had reduced their numbers by spring.

Rainbow trout migrated from Boca Lake and moved into the Blitzen River and its tributaries to spawn.

The last year in this segment of the ecological history of the Harney Basin was characterized by cold winter temperatures and a lack of precipitation. Canada Goose nesting success was 68.2 percent, Mallards 85.7 percent, Gadwalls 59.5 percent, Cinnamon Teal 66.7 percent and Redheads 40 percent. Gulls nested in north Malheur Lake after abandoning their colony in Harney Lake. Great and Snowy Egrets nested in separate colonies in Malheur Lake in contrast with former mixed aggregations.

Bobcats showed an increase in 1949. Jackrabbits were extremely abundant and a number of haystacks were completely undermined when rabbits ate the alfalfa to a height of 18 to 20 inches until the stacks tilted over on one side, then the process would be repeated. Pocket Gopher numbers remained high, but meadow voles showed a decline from 1948.

1950 - 1960

Water conditions in 1950 were comparable to those in 1949. The spring was dry and the shortage of green grass and browse resulted in the starvation of many yearling fawns. This was a general condition throughout the Harney Basin. Large numbers of jackrabbits again congregated in the hay meadows. A bounty of 5 cents per set for rabbit ears had depleted the bounty fund of Harney County long before the winter had passed. A total of 16,904 muskrats were taken by trappers during the winter months, 6000 more than in 1949.

Production of Canada Geese was estimated at 3000 on the refuge. Gadwalls and Canvasbacks decreased as did Ruddy Ducks slightly. Gulls nested in north Malheur Lake, but as the lake level was receding fewer grebes and no pelicans nested. A spectacular increase of raccoons during the past year raised the importance of this species to the ~~number one~~ ^{primary} predator in the Blitzen Valley. In late winter a rabbit die-off occurred and by fall jackrabbits and cottontails were present in less than 10 percent of their 1949 numbers. Meadow voles also declined sharply.

The Silvies River had a heavy sustained flow of water in 1951, and a substantial surplus flowed into Malheur Lake. Both Silver Creek and Blitzen River had substantial flows. Nesting duck populations were little changed except for a slight increase in Mallards and Cinnamon Teal.

No extensive grebe colonies were located, but there was a colony of about 200 Eared Grebe pairs in Boca Lake. For the sixth successive

year no White Pelicans nested in the Basin. Cormorants nested on muskrat houses in Malheur Lake and on the spoil-bank islands in Boca Lake. A California Gull colony in north Malheur Lake numbered about 3000 birds. Fifty pairs of Great Egrets and 10 Snowy Egrets were nesting near Cole Island Dike.

Striped skunks were common and 62 were trapped on the refuge along with 2 spotted skunks.

In 1952 the general run-off was in excess of normal and extremely high at times. The average 10 year flows on Silvies River was 97,000 acre feet and the Blitzen River 65,000 acre feet. In 1952 flows were 150,000 acre feet and 120,000 acre feet, respectively. Water reached the Narrows on 15 April.

Gadwall nesting was reduced, because much of their nesting habitat was inundated. Gulls, Snowy Egrets and Shorebirds were effected by the high water and little or no nesting occurred. However, six pairs of White-faced Ibis were able to nest^d. Franklin's Gull numbers were continuing to increase, while Canvasbacks and Redheads continued to decline. About 1500 waterfowl were estimated to have died of botulism. California Quail increased, and were at their highest level in 15 years. In the fall of 1952, 1000 Chukars were released along the rimrocks north of Frenchglen. Sage Grouse numbers continued to decline.

Muskrat numbers were building and were the highest since 1949, and jackrabbit populations were increasing.

Carp () were accidentally introduced into the Harney Basin in the early 1920's when bass were planted in Malheur Lake that had been captured from Columbia River Slough. The species was not

evident in Malheur Lake in the late 1930's and early 1940's. A definite buildup in the carp population was evident after the high water in 1952. The early 1950's saw a rapid increase in carp and a sharp decline in waterfowl use during fall migration (Refuge EIA, Proposed Carp Control on Malheur NWR - 1977).

Late runoff in 1953 resulted in many waterfowl having their nests flooded, however, later nesting species were extremely successful. Canada Goose nesting success was 87 percent. Black-crowned Night Herons had declined for the past 3 years, but 80 pairs nested in 1953. One hundred and 60 pairs of Great Egrets, 210 pairs of Great Blue Herons, 60 pairs of Snowy Egrets, eight pairs of White-faced Ibis and 30 pairs of cormorants also nested. Thirty Caspian Tern pairs and 200 Ring-billed Gull pairs were nesting on an island in Harney Lake. Also about 30 White Pelicans nested on the island for the first nesting record since 1945.

Ring-necked Pheasants were only about one-third of their usual numbers in the Blitzen Valley, but California Quail were present in their largest numbers ever. Less than 10 percent of the 1950 Sage Grouse population remained.

Antelope had decreased considerably since 1951.

In 1954 water levels were below normal; however, a total of 22,412 muskrats were trapped in Malheur Lake and 5000 on private lands in the Basin. Raccoons remained the number one egg predator on the refuge and skunks and bobcats were still common.

Avocets returned to Malheur Lake to nest, but the Long-billed Curlew and Black-necked Stilt continued to decrease. For the second

consecutive year the gull-Caspian Tern-pelican colony occupied the island in Harney Lake. In addition to these birds about 25 Snowy Plover pairs and 25 avocet pairs nested on the island. Fall duck use days dropped from 22.5 million in 1953 to 13.5 million in 1954 as the carp continued to increase in Malheur Lake.

Low water conditions occurred in 1955. No water made it to Malheur Lake from the Silvies River and very little from the Blitzen. Carp had penetrated well up into both the Silvies and Blitzen drainages. Muskrats declined from 1954 and only 6032 were trapped in Malheur Lake. Fewer skunks were seen and only seven were trapped. Rabbit numbers were low and small rodent populations were the lowest in the past 10 years.

Many permittees augmented their refuge cattle feed with concentrates, which added to the carrying capacity of a number of fields. Some accumulated hay was also fed, which also reflected an increase in AUMs in some areas.

The number of resident ducks and geese in the Blitzen Valley decreased about 25 percent. Coots died throughout the refuge and it was estimated 25,000 were lost. No pelicans nested on the refuge, but their numbers increased in the summer until about 20,000 were using Malheur Lake.

No aquatic ~~waterfowl~~ ^{for waterfowl} food was present in the lake. In the fall the lake and Blitzen Valley were rotenoned to reduce carp populations, resulting in an estimated kill of 1.5 million carp.

Above normal water was available in the Harney Valley in 1956.

Heron, egret, cormorant and pelican numbers were reduced because of ~~the carp treatment program had reduced~~ a reduction in the ~~carp~~ food supplies. By fall, lake productivity was greatly improved and over 750,000 ducks, geese and coots were using it. A peak of 10,000 Whistling Swans was reached in early December. On 8 November the Canvasback was the most abundant waterfowl species on the refuge, with an estimated 82,000. Two duck rarities, an Oldsquaw and White-winged Scoter, were recorded in the fall. An estimated 400,000 coots were on the refuge in September.

Total fall duck use days in 1956 was 24,057,000 compared with 7,060,000 in 1955.

Water conditions were excellent in 1957 and flows were close to the high record set in 1952. Muskrats were once again increasing. Approximately 130 bobcats were trapped on the refuge.

Snow Geese were in good numbers and an estimated 100,000 were using north Malheur Lake in the spring. In the summer large numbers of Blue-winged Teal were evident, with a total estimate of 760 pairs. A Black-crowned Night Heron colony was located in tules 2 miles east-northeast of the Narrows. Other species of colonial birds were nesting in their regular areas on the lake. California Gulls (400 pairs) were again nesting on the island in Harney Lake. In addition, 12 pairs of Caspian Terns were nesting. Prairie Falcons had been seldom seen and no young were known to have fledged in the county.

An abundance of invertebrate life in Harney Lake attracted 250,000 Shovelers and Green-winged Teal at one time in the fall. Peak fall populations of ducks were the highest ever recorded. Duck use days

numbered 31 million. Up to 18,000 Whistling Swans were recorded at one time. Peak duck numbers were estimated to be over 600,000, with 40 percent of this use on Harney Lake. The introduced Trumpeter Swan population consisted of: 17 cygnets transferred in 1957; 6 adults transferred in 1956; and 7 adults ^{which} were transferred either in 1955 or 1956. Over 150,000 Canvasbacks were present on Malheur Lake on 22 October. A severe botulism outbreak occurred in the fall and an estimated 10,000 waterfowl were lost.

Like the previous year, runoff was above normal in 1958. California Quail were extremely abundant and 1,516 were trapped on the refuge for transplanting purposes elsewhere. Pheasant numbers were higher than in the previous few years. Chukars were becoming evident, but the Gray Partridge existed in limited numbers.

There were 21,000 duck pairs, 18,000 coot pairs and 1700 Canada Goose pairs using the refuge in 1958. Trumpeter Swans raised broods (4 cygnets) for the first time since the species was introduced. An Eared Grebe colony, consisting of 300 nests, was in west Harney Lake. The first nesting record for the refuge of the Horned Grebe occurred on 24 June. A total of 230 pairs of White Pelicans nested on the island in Harney Lake, but all of their nests were destroyed by a storm. California and Ring-billed Gulls nested in Harney and Malheur Lakes, but no Caspian Terns nested. Both Swainson's Hawks and Long-eared Owls were nesting in willows in the Blitzen Valley.

Small rodents and rabbits increased substantially and major damage to vegetation occurred. Several hundred jackrabbits were killed on the refuge lawn. Meadow vole numbers had declined by the

end of the summer. Hundreds of Short-eared Owls used the refuge during this rodent outbreak, while Swainson's and Red-tailed Hawks increased in nearby valleys.

Carp were first recorded at Double-O in 1958, and the species was once again becoming abundant in Malheur Lake. A drastic decline in waterfowl use on the lake followed this increase. Only 150,000 ducks were present at the peak of fall migration and Whistling Swans were only 12 percent of ^{what} their numbers ^{had been} in 1957. Redhead use was about one-third of that from the previous year and Canvasback use was only 5 percent.

Bobcat numbers were down, while the mink population was increasing. There were an estimated 30,000 muskrat houses on Malheur Lake in the fall, up 10,000 from 1957.

Climatic changes occurred in 1959 and it was the driest year in the past 25. In the spring on Malheur Lake, Canvasbacks dropped to 1000 birds. Greater Sandhill Cranes arrived the earliest ever (7 February) after the dry ^{and} mild winter. Quail populations continued to flourish and nearly 2000 were trapped and transplanted elsewhere. Duck pairs were reduced and many females never nested, resulting in few broods being produced.

For the first time in many years White Pelicans nested in Malheur Lake. Pairs nested on Cole Island Dike, but coyotes destroyed all of the young. In addition, about 60 pairs nested on islands in Harney Lake, but only seven young were fledged. Both Eared and Western Grebes numbers were down on Malheur Lake and the Blitzen Valley. A colony of several hundred Western Grebes was in west Harney Lake,

but all nests were destroyed by high wave action. In early June, 25,000 Eared Grebes were feeding in Harney Lake. About 200 Caspian Tern pairs nested on the Harney Lake island. No gull colonies were known in Malheur Lake.

Antelope numbers were down, as were mule deer numbers. A major die-off of voles, rabbits and muskrats occurred. Only two muskrat houses were seen in Malheur Lake. Raccoon numbers were above normal and coyotes were present on the refuge in the largest numbers seen in recent years.

In the fall swans accumulated 37,000 use days, ducks 10.4 million use days and geese 771,000 use days. Peak numbers were Whistling Swan 700, geese 13,400, ducks 182,400 and coots 205,000. Canvasbacks peaked at 600 birds; however, 50,000 Ruddy Ducks used Harney Lake. Numbers of upland game birds were down considerably.

1960 - 1969

Waterfowl use in the Basin continued to decline in 1960 as water conditions were poor and carp populations excellent. Whistling Swan use was the lowest since 1956, peaking at 3600 individuals. However, the outlook for nesting waterfowl was considerably improved over ^{the previous} ~~last~~ year. Duck species which showed a decided increase in use from the preceding year were Lesser Scaup and Ruddy Ducks. Those that showed a decrease were Green-winged Teal, American Wigeon and Northern Shoveler. Canada Goose use dropped almost 50 percent, while summer duck use increased almost 60 percent. An unusual record was of two Snow Goose goslings produced on Malheur Lake. In the fall Shovelers concentrated on Harney Lake and on 13 September 96,000 were present. In mid-September there were 175,000 ducks ~~on the refuge~~; however, duck use days were the lowest (6.68 million) since records had been kept on the refuge (1952). American Wigeon were greatly decreased, while Canvasbacks had increased to 9000, up from 600 in 1959. An immature Greater Scaup was collected, and an Oldsquaw was sighted on 25 November.

White Pelicans successfully nested on Harney Lake, as did Caspian Terns and California Gulls. California Quail numbers were up slightly, but had not reached the peak that occurred in 1958. Both Swainson's and Red-tailed Hawk populations declined.

Jackrabbit numbers were increasing, ~~however, the population had~~ ^{but} not reached their ^{before} ~~peak~~ of a few years ^{ago}. Muskrat numbers were still low in Malheur Lake. Coyotes had died off the preceding year, but reproduction was fair in 1960. On Steens Mountain, bighorn sheep were re-introduced.

About 400,000 carp were poisoned on the refuge in the fall.

Water conditions in 1961 were the bleakest since the drought years of the 1930's, and spring duck use was the lowest in 9 years. Forty-two Trumpeter Swans were on the refuge in the spring. Only 7,375 ducks, 4050 coots and 965 geese were produced. Whistling Swans peaked in the fall at 200. The peak fall population of ducks was 32,550, the lowest in over 2 decades.

No Great Blue Herons, Black-crowned Night Herons or Snowy Egrets nested; however, Great Egrets attempted to nest in Malheur Lake. About 150 pairs nested, but the site dried before any young hatched. A small colony of 10 pairs was active in willows north of Wright's Point and young were successfully raised. No gull or Caspian Tern colonies were noted on the refuge, but a small colony of gulls had formed south of Burns. Black and Forster's Tern populations were far below normal. In 1961, 500 ^{by} Black and 500 Forster's used the refuge compared to 30,000 ^bBlacks in 1957 and 30,000 Forster's in 1954. Only one Swainson's Hawk nest and one Golden Eagle nest were located during the year. A few Mountain Quail coveys were still present among the rimrocks of the Jackass Mountains.

Muskrat populations remained low, but jackrabbits and cottontails were on the up-swing of their cycle.

By fall, Malheur Lake contained only 500 acres of water. The lake was again poisoned for carp and 150,000 were killed. The average weight per fish was 8.5 pounds and the average length was 26 inches. After the carp poisoning, White Pelicans left the Basin and none was seen ^{10/11}in the fall.

For 4 years the Basin was plagued with low water and 1962 was no exception. ~~Both~~ ^{2 =} spring swan and goose use were down, but duck use was higher, arresting the steady decline of the past 9 years. Gadwall production was three times higher than in 1961 and Cinnamon Teal double. A total of 1100 Canada Goose goslings were produced.

A colony of 125 Great Egrets was successful. No Snowy Egrets, Black-crowned Night Herons or Great Blue Herons nested in 1962. White-faced Ibis were present in greater numbers than ever recorded in the past 15 years. A colony of 28 pairs was found nesting 3 miles south of Malheur Lake, in the Blitzen Valley. White Pelicans again did not nest.

The jackrabbit population continued to increase and numbers throughout the Basin were greater than ⁱⁿ the previous year. Muskrat numbers were still very low owing to the lack of habitat.

Water conditions improved in 1963 and much of the Blitzen Valley received water, but little reached Malheur Lake. On 4 April 5100 Ross' Geese were present in the Harney Valley and 1900 were still in the area on 24 April. Waterfowl populations in the summer were 2 to 3 times greater than in 1962. Pintails had increased as a nesting species, raising 1900 young on the refuge. Total waterfowl use in the fall was better than it had been since 1959. Duck use days increased to 9.9 million.

Snowy Egrets (25 pairs), cormorants (50 pairs) and Black-crowned Night Herons (125 pairs) successfully raised young for the first time in several years. Pelicans again did not nest. Both quail and chukar production was excellent, but no ^{a single} Gray Partridge was seen.

of small rodents
~~Small rodent~~ populations were high and jackrabbits were also abundant. Antelope populations were up by 15 percent, and muskrats were making a slow comeback.

Water conditions continued to improve in 1964. ~~Snow~~-packs were near normal and heavy rains in late May provided excellent water conditions. Whistling Swans had a spring peak of 1300 and a fall peak of 2500. There were three known broods of Trumpeter Swans. Snow Geese peaked at 61,100 in the spring and 15,000 in the fall. Overall duck use in the spring was up slightly, but a marked increase was noted in the fall. Gadwall, Cinnamon Teal, Mallard and Redhead were the four top nesting species and are listed in the order of their abundance. Coot use in 1964 was 9.3 million use days, compared to 4.6 million in 1963.

The colonial nesting colonies consisted of 150 Great Egret pairs, 30 Snowy Egret pairs, 100 Black-crowned Night Heron pairs and only 20 Great Blue Heron pairs. White Pelicans were no longer nesting in the Basin. A total of 850 Eared Grebe pairs nested in four separate areas. Gulls did not nest and terns nested in only small numbers. California Quail continued to be the most abundant upland game bird.

Jackrabbits were abundant in July and August, but their numbers were reduced by fall. Muskrat populations continued to be low and no houses were present in Malheur Lake by December.

A December 1964 flood inundated much of the Blitzen Valley and by 26 February 1965 water was flowing through the Narrows. Sago pondweed production in Malheur Lake was excellent. Whistling Swan numbers were higher, peaking at 5000 in the spring and 5600 in the fall.

Trumpeter Swan production see Appendix D. Gadwall, Cinnamon Teal, Redhead and Mallard were the most common nesting waterfowl (in that order), accounting for 75 percent of the breeding pairs. An estimated 37,000 ducks and 50,000 coots were produced. Peak fall population of ducks was 407,900. A Ring-necked Duck was observed with a brood for the second consecutive year.

An estimated 9000 Eared Grebes were produced, and the three species of gulls nested in small numbers. Black and Forster's Terns nested in their greatestst numbers since 1958.

Muskrats increased greatly in Malheur Lake and 500 houses were counted in December 1965. Low populations of mink and beaver continued, but coyote numbers were at a high level.

Drier conditions returned in 1966. Very little water reached Malheur Lake from the Silvies River. The Blitzen River almost ceased flowing. Whistling Swans peaked at 15,000 in the spring, but populations were reduced in the fall, peaking at 8000. Only 13,000 ducks were produced on the refuge. Production of coots was only a small fraction of those produced in 1965. Colonial nesting species had an excellent year. Cormorant pairs increased from 30 in 1965 to 125 in 1966, and Black-crowned Night Herons 600 pairs, up from 250 in 1965. All other species showed increases. Up to 500 White-faced Ibis were present in the fall. One Eared Grebe colony in Malheur Lake totalled 1000 nests. Black-necked Stilts and avocets were more common in the summer on the mudflats in Malheur Lake. Franklin's Gull pairs had increased to 100, and California and Ring-billed Gulls numbered about 50 pairs each. One Gray Partridge was seen for the first time since 1961.

Lower water levels reduced the muskrat population. Raccoons continued to be abundant. The species was reported as common along the streams on Steens Mountain, and one was found near the south end of Catlow Valley. Bobcat numbers were low, as were those of jackrabbits.

Very little water again reached Malheur Lake from the Silvies River in 1967; however, good flows did occur in the Blitzen River. Snow Goose use was up 19 percent over 1966. The fall migration peak was 13,400 compared to only 5000 the preceding year. However, breeding duck pairs were down about 3000 pairs from 1966, but production was higher with 22,800 young produced. Mallard production was estimated at 1900 young. The species was now the fourth most common nesting duck behind Gadwall, Cinnamon Teal and Redhead. The peak fall number of ducks was 169,700. A spring peak of 100,000 and fall peak of 112,800 coots were lower than in previous years. However, production estimates of 12,600 was up slightly.

Caspian Terns were seldom observed and there was no known nesting. A covey of Gray Partridge was seen for the last record of the species on the refuge. A Long-eared Owl nest was found among the willows along the Blitzen River

Antelope populations increased for the first time in several years. The muskrat population in Malheur Lake exploded and approximately 2600 were counted in the fall. Mink numbers continued low; however, beaver populations were increasing. Jackrabbit numbers continued low and small rodents were seldom seen. Raccoons continued to increase.

Carp populations on Malheur Lake were again building.

In 1968 water conditions were again low. The Blitzen Valley received below normal water and no water was received from Silver Creek in the Double-0 area. The Silvies River had little flow and no water reached Malheur Lake from this system. Canada Geese pairs were down to 900, compared to 725 in 1967 and 940 in 1966. About 13,000 young ducks were produced, compared to the 1953 - 1961 average of 30,000. Spring waterfowl use was up 13 percent over 1966, but fall use declined sharply (1966 - 194,900; 1967 - 63,000). Coot use was the lowest since 1961.

Eared Grebes nested in greater numbers in Malheur Lake. Two colonies of 500 nests each were found in the central portion of the lake. Forster's and Black Terns increased about 45 percent, but Caspian Terns were becoming more rare. There were no Swainson's Hawks nesting on the refuge in 1968.

Muskrat populations declined from 13,000 in 1967 to 1500 in 1968. A mountain lion was seen about 9 miles north of Frenchglen for the first authenticated sighting on the refuge. Black-tailed jackrabbits were increasing as were small rodent populations.

Carp control activities were initiated on 23 October. Total carp kill was estimated at 245,000. The average weight per carp was 7.5 pounds.

The decade ended with above normal precipitation and excellent water conditions in the lowlands. In 1969, the Blitzen River was predicted to run 164 percent of normal, Silvies River 127 percent and Silver Creek 167 percent. Even with the good flow forecast Malheur Lake never reached the Narrows. Whistling Swans peaked at 5000 in the spring, and 14000 in the fall. Fall use was up 93 percent over 1968.

A total of 13,100 duck pairs produced 22,800 young. ¹On migration, spring duck use was down 51.9 percent, but fall use was up 35.0 percent. The fall Canvasback population was 14,600 compared to 1400 in 1968. Generally, coot use continued to decline and their numbers were down 24.6 percent. However, fall use increased and the species peaked at 80,000, up from 16,000 in 1968. Greater Sandhill Crane nesting success was 59.1 percent, higher than in previous years.

There were six major colonies of large wading birds in Malheur Lake. For the fourth year most species increased. A total of 138 Franklin's Gull pairs nested. Horned Grebes nested in the Blitzen Valley for the first time since 1958, but Eared Grebe pairs declined to 650. Black and Forster's Terns were down 20 percent over 1968. Two pairs of Swainson's Hawks nested on the refuge.

A striped skunk was seen for the first record in several years. Bobcat numbers remained low, while raccoons continued to increase. There were also indications that mink numbers were increasing.

1970 - 1977

The Silvies River contributed substantial water to Malheur Lake in 1970, and the Blitzen River also had above normal flows. Whistling Swans peaked at 15,000 in November. ^{As} In 1957, ^{when} the largest number of swans were recorded 2 years after the carp control program of 1955. ¹ Also in 1970, swan use day peaks followed by 2 years the control program of 1968. In both years low lake levels coupled with carp control were followed by increased lake acreage and increased sago pondweed production. Canada Goose production was 1350, down from 1500 the preceding year. There were 16,000 duck pairs that produced 33,000 young. Canvasbacks peaked at 21,000 in October. Total duck use days ^{were} ~~was~~ up 33.9 percent, and coots were up 15.6 percent. A total of 2,929 [^] Greater Sandhill Cranes were using the refuge on 5 October.

There were six known nesting colonies of wading birds on Malheur Lake again this year. However, most species were down in numbers from 1969. Great Blue Herons were also nesting in willows near Double-0, where seven nests were located. Eared Grebes continued to decline and only 500 pairs could be located. Western Grebe numbers were up from 350 pairs in 1969, to 470 pairs in 1970. Franklin's Gulls increased to 335 nesting pairs, but the other two species of gulls did not nest on the refuge. There were eight active Golden Eagle nests surrounding Malheur NWR, down from 10 ^{to} ~~to~~ previous year. Two pairs of Swainson's continued to nest, and Peregrine Falcons were observed six times.

During the year, 31,675 head of cattle and horses grazed a total of (2) 129,718 AUMs. Much of the refuge was over grazed.

Water conditions continued good through 1971 and most of the lowlands

received substantial flows from the three principal water systems. Whistling Swans peaked in the spring at 11,600, but fall numbers declined and were down by 3800 birds from 1970. More breeding pairs of Canada Geese were on the refuge, with 1030 pairs, up from 650 the year before. These pairs produced an estimated 2400 goslings. Duck pairs totalled 20,700, producing 44,000 young. Ruddy Ducks responded to improved habitat and 2880 pairs nested in Malheur Lake. Duck use days during spring and fall migration were up 37.9 percent (29.2 million) over 1970, and up 9.3 percent from the 17 year average. Canvasbacks peaked in the fall at 30,700. Coot use days increased 3.1 percent above the previous year, but were still 47 percent below the 17 year average. Production was estimated at 41,300 young, up 53.0 percent from 1970.

There were nine known nesting colonies of large wading birds and gulls on Malheur Lake. The number⁷ of pairs were: Double-crested Cormorant 45; Great Blue Heron 110; Great Egret 150; Snowy Egret 35; Black-crowned Night Heron 750; White-faced Ibis 20; and Franklin's Gull 400. Two pairs of Horned Grebes nested in the Blitzen Valley and Eared Grebes increased to 1000 pairs. There were an estimated 500 pairs of Western Grebes. About 100 pairs of California Gulls nested about 4 miles northeast of Frenchglen, which was the first known nesting attempt since 1965. Pheasant populations continued to decline, while Chukars were increasing. Three Swainson's Hawk nests were located in the Blitzen Valley, and there were four observations of the rare Peregrine Falcon.

Mule deer increased on the refuge and antelope numbers remained

stable. Muskrats were increasing on Malheur Lake.

Above normal run-off was again experienced in all three watersheds in 1972. Both the Silvies and Blitzen Rivers had good flows into Malheur Lake. Harney Lake was filled to near capacity by early summer. Whistling Swans declined to 5000 in the spring, but fall populations peaked at 15,500. A total of 1630 young Canada Geese were produced, down from the preceding year. Duck breeding pairs dropped to 16,500, but production was estimated at 33,700 young. Ducks peaked at 116,500 in the spring and 145,100 in the fall. Canvasbacks were ^{at} only half ^{the levels} ~~that~~ recorded in 1971, depicting the lack of sago pondweed in the lake. Spring coot use was up, but ^{was} down in the fall. Production was estimated at 39,600 young.

A single California Gull nest was found in Malheur Lake for the first known ~~lake~~ record ^{there} since 1965. Pheasants, California Quail and Chukars were at their lowest levels in many years. ^{Low} Temperatures that ~~dropped to~~ ^{dropped to} (-30°F in December 1971) were believed responsible for their decline. The Peregrine Falcon was only seen one time, and Swainson's Hawks were not found nesting on the refuge.

The muskrat population exploded once again. In 1971, 1310 houses were counted compared to 6802 in 1972. The estimated rat population was at 37,400 in the lake. The long standing coyote poisoning program on the refuge was terminated in 1971-72.

No water was received from Silver Creek, and no significant amounts of water flowed into Malheur Lake from either the Silvies or Blitzen Rivers in 1973. Nesting success for most species of waterfowl, shorebirds and marshbirds was low and predation rates high. Only 680 Canada Geese

were produced. Nesting success was only 27.3 percent in the Blitzen Valley. Ducks were reduced considerably during spring and fall migration. Duck pairs numbered 12,300, producing only 13,300 young, down 60.6 percent from the previous year. Only 2 young Sandhill Cranes fledged from 235 nesting pairs. Franklin's Gulls continued to increase and an estimated 1000 pairs nested in Malheur Lake.

Jackrabbit populations had "crashed" during the previous winter and coyote populations became extremely abundant on the refuge during the summer. During the winter 15,700 muskrats were trapped in Malheur Lake, but by the following October the population was reduced and only 4600 were estimated in the lake.

Ample run-off occurred in 1974 and most of the lowlands received adequate water. However, goose use was down 41.5 percent from 1973. Snow Geese peaked in the fall at 20,800 compared to 75,100 the previous year. Duck production was up to 21,300 young. The principal nesting species were Cinnamon Teal, Gadwall and Redhead. Nesting success was 31.9 percent. The peak number of ducks in the fall was 58,000 as the carp population continued to increase. Coots produced 9400 young, up from 6700 in 1973.

Colonial species nested in seven colonies. Number of pairs include: Cormorant 75; Great Blue Heron 200; Black-crowned Night Heron 1000; Great Egret 350; Snowy Egret 140; White-faced Ibis 80; Franklin's Gull 1000; and California Gull 10. The first sighting of the Cattle Egret () occurred on 13 August. The species had first arrived in the United States in 1952 and had spread both north and west across the continent. Again the nesting population of Greater

Sandhill Cranes produced only two young. Pheasant populations remained low.

Muskrat populations continued low. Coyote numbers were still high, but an outbreak of distemper had reduced the population by late summer.

In 1975 excellent snowpacks provided an abundance of water in the lowlands. At the end of June, Malheur Lake covered 55,000 acres. Swan use increased considerably in the spring of 1975. Over 20,000 Whistling Swans were on Malheur Lake in late March. About 1000 young Canada Geese were produced on the refuge; Nesting success was 31.4 percent. Over 17,000 duck pairs nested in the Harney Basin, with 58 percent on the refuge and 42 percent on private lands. Total ducks produced in the Basin was almost 34,000; 53 percent on the refuge and 47 percent on private lands. The fall migration peak was 105,000. The fall peak of geese was 10,000 and swans 8200.

The most important shorebird nesting area in the Basin was the Silvies River Floodplain. Estimated shorebird breeding populations were: Long-billed Curlew 1034; Willet 1633; American Avocet 1696; Black-necked Stilt 77; and Wilson's Phalarope 5005. In the fall shorebirds peaked at 35,500 birds. A colony of Ring-billed and California Gulls was located southeast of Burns. It consisted of 500 birds in 1975, and probably ^G 292 = ²⁹ gulls that formerly nested on Malheur Lake had ^{probably} moved to this colony. Black-crowned Night Herons decreased to 360 pairs and no Franklin's Gulls were known to have nested.

Water conditions remained about the same in 1976. Total run-off from the three water systems was near normal. Whistling Swans peaked in the spring at 12,800, down from the previous year. Snow Geese

peaked at 52,166 in the spring and 6000 in the fall. Ducks accrued 12.9 million use days in the Basin; 32 percent on the refuge, 43 percent on the Silvies River Floodplain, and 25 percent on other private lands. Duck production was estimated at 50,000; 64 percent on the refuge and 36 percent on private land. A total of 1386 pairs of Canada Geese were present in 1976 (790 pairs-refuge; 596 pairs-private land). In the fall, the peak number of ducks was 97,000.

An estimated 17,³⁰⁰~~286~~ shorebirds were using the Basin during the nesting season, ~~and~~ peakedⁱⁿ in the fall at 24,000. The gull colony southeast of Burns was again active and had increased to 1000 birds. About 200 pairs of Franklin's Gulls nested in Malheur Lake. No drastic changes occurred in the number of colonial nesting species (Paullin, et al. 1977).

Beaver increased in the Blitzen Valley, and muskrat numbers were stable with about 4000 individuals in Malheur Lake. Jackrabbit numbers were increasing.

In the final year water conditions were below normal in the Harney Basin. Both Silver Creek and Silvies River had low flows and much of the area north of Malheur Lake remained dry through the spring and summer. The snow pack on Steens Mountain was in better condition and the Blitzen Valley fared well in 1977. Use by all waterfowl was ^aeffected _{of} by the drought and the poor condition of Malheur Lake. Waterfowl use days were as follows: Whistling Swan 254,190; geese 1.7 million; and ducks 6.5 million. By late September, Malheur Lake contained only 12,000 acres of water. No young Trumpeter Swans were produced. Snow Geese in the fall peaked at only 1000 birds. Canada Goose production

was down down 27 percent. On the refuge 10,458 pairs of ducks produced 15,800 young, and less than 1000 young were produced elsewhere in the Basin. The spring peak of ducks was 40,000, and in the fall only 30,400. The breeding population of coots declined 38.6 percent and only 3610 young were produced.

Gulls continued to use the colony southeast of Burns, but no young were produced. Franklin's Gulls again nested in Malheur Lake (250 pairs). White-faced Ibis increased significantly and their nests numbered 110, compared to 25 in 1976.

Muskrats increased and at the end of 1977 there were an estimated 19,000 in Malheur Lake.

On 22 and 23 September Malheur Lake was again treated for carp.

Ecological information that was available on the Harney Basin since 1935 was provided primarily by narrative reports from Malheur NWR. Little information was available on the vegetative changes that occurred during this period. However, grazing had steadily increased on the refuge, until 126,593 A.U.M.s occurred in 1973. Since then A.U.M.s have been declining and at the end of 1977 total A.U.M.s were down to 58,214. Willows ^{have} ~~had~~ increased and many acres of lowland meadows that had been abused by overgrazing were returning to ideal nesting habitat for many species of waterfowl, shorebirds, marshbirds, raptors and songbirds. What long-term effects this will have on the density and diversity of the fauna remains to be seen.